Ethiopian TVET-System

ELECTRONIC COMMUNICATION AND MULTIMEDIA EQUIPMENT SERVICING Level II

Based on May 2011 Occupational Standards

October, 2019

Module Title: Carrying out preventive maintenance in Electronics Communication & Multimedia Equipment

TTLM Code: EEL ICMS2TTLM 1019 v1

This module includes the following Learning Guides

LG42: Prepare unit and workplace

LG Code: EEL ICS2 M11 LO1-LG42

LG43: Perform preventive maintenance

LG Code: EEL ICS2 M11 LO2-LG-43

Instruction Sheet	LG42: Prepare unit and workplace

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Making workplace/equipment ready for maintenance
- Verifying preventive maintenance history in line with the company procedures
- Finding or acquiring ***Service manuals*** and ***service information*** required for preventive maintenance as per standard procedures.
- Setting or Arranging workplace for repair job in accordance with company standard procedures
- Preparing necessary ***tools***, ***test instruments*** and ***personal protective equipment*** in line with job requirements

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Make workplace/equipment ready for maintenance and verifying preventive maintenance history in line with the company procedures
- Acquire ***service manuals*** and ***service information*** required for preventive maintenance as per standard procedures.
- Set / Arrange workplace for repair job in accordance with company standard procedures
- Prepare necessary ***tools***, ***test instruments*** and ***personal protective equipment*** in line with job requirements

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4”.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3 and Self-check 4” **in page -42, 45, 51-52 and 55** respectively.
5. If you earned a satisfactory evaluation from the “Self-check”
6.

Information Sheet	Making workplace/equipment ready for maintenance

Introduction

1.1. MAINTENANCE MANAGEMENT

1.1.1. MAINTENANCE:

The basic principle of maintenance is to extend the useful life of an asset. A proper Maintenance will improve the production capacity with only existing capacity utilization. Maintenance is usually viewed, as a repair function of maintenance is composite in nature. A wide range of activities are involved in it. In fact maintenance keeps our entire system to be reliable, productive and efficient. There is no definite maintenance procedure for a particular plant. It varies from one plant to others.

1.1 .2 OBJECTIVES OF MAINTENANCE

The principal objectives of maintenance activity are as follows

1. To minimize the breakage and maximize the plant availability
2. To extend the useful life of assets by minimizing wear & tear and deterioration
3. To ensure the operational readiness of all equipment.
4. To ensure the safety of workers.
5. To establish a satisfactory working condition.

By systematic maintenance, it is possible to achieve Substantial savings in money, material & manpower

1.2.3 TYPES OF EQUIPMENT MAINTENANCE

- Restoration Maintenance
- Preventive Maintenance
- Prediction Maintenance

1.2.3.1 RESTORATION MAINTENANCE

Restoration maintenance, also called repair and corrective maintenance, is the most common maintenance performed. Restoration maintenance consists of repairing a broken or damaged piece of equipment to restore necessary operation conditions. Another part of restoration maintenance includes replacing abnormal or worn parts that are causing films, plates, or production sheets to be out specification. Restoration maintenance is basically a fix-it-when-it breaks function, addressing sporadic and sudden equipment losses, which are actually unscheduled equipment downtime. The

maintenance operators become fire fighters, fixing Equipment and waiting until something else breaks.

1.2.3.2 PREVENTIVE MAINTENANCE

Preventive maintenance is naturally carried out before any interruption of production and major breakdown. This maintenance is carried out in predetermined intervals. Preventive maintenance will not only prevent the breakdown, but also it will improve the output quality of the product, and condition of the machine. This preventive maintenance is most successful one, and it is adopted in many organizations. The best way to perform preventive maintenance consistently is to develop operational checklists. The checklists should be designed with the maintenance-activity steps in proper order for easy understanding. The checklists should be initialed and dated by the person performing the maintenance. Establishing maintenance checklists and procedures for each piece of equipment maximizes the preventive maintenance program, and helps accelerate training as well.

1.2.3.3 PREDICTION MAINTENANCE

Prediction maintenance takes preventive maintenance to a higher level. Prediction maintenance utilizes more state of the art technology to predict when equipment components will need maintenance before they fail. Major maintenance and overhaul intervals are now being determined by scientific methods and accurate data analysis. Prediction maintenance requires monitoring specific elements that could cause catastrophic failure of the equipment.

PLANNED MAINTENANCE

1. **Scheduled Maintenance:** In this type of maintenance is done to avoid break down. A schedule is framed for an instrument or machine. According to that all works like inspection, lubrication, repair.
2. **Predictive Maintenance:** Predictive maintenance is to recognize the cause of any change of physical condition of a system. In this method, sensing, measuring and monitoring techniques are followed by using instruments like vibrations analyzer, axial displacement monitors, optical devices, non-contacting sensor etc. The main advantages of this system are to inspect the troubles of internal parts without disassembly.

3. **Preventive Maintenance:** Preventive Maintenance is naturally carried out before any interruption of production and major breakdown. This maintenance is carried out in predetermined intervals. Preventive Maintenance will out only prevent the breakdown, but also it will improve the output, Quality of product, and contain of the machine. This preventive Maintenance most successful one and it is adopted in many organization.

The repairs, which are carried out at a planned interval under preventive Maintenance, can be broadly classified as four categories involving different volume of work and each of which followed the other in a sequence. These categories are

- Inspection-I
- Small repair-S
- Medium repair-M
- Complete Overhaul-C

These repairs are carried out on the equipment in a sequence, which well defined for the particular equipment. For example the repair cycle of a center i.e.C-I1-S1-I2-S2-I3-M1-I4-S3-I5-S4-I6-M2-I7-S5-I8-S6-I9-C-I1…… This means that after a plant interval (say 6 months on 2 shift basis). The volume of work to be carried out in each of these repairs–categories (I, S, M, C) are indicated below in brief.

Inspection-

- External inspection for proper functioning of all the mechanisms at all speeds and feeds.
- Regulation and adjustment of couplings, clutches, bearings, wedges etc.
- Cleaning of oil and coolant filters, lubrications lubricating distributors chip or dust removes from guides.
- Tightening of all bolts and nuts and replaced dam aging one.
- Replacing of oil.

Small repair-S

- All the operation of inspections.
- Disassembly of 2 to 3 units. Which are excessively worn-out /or dirty, disassembly of those units completely part wise, washing out parts and reassembly of units.
- Carrying out various regulations a mentioned at “Inspection” with necessary repairs (if called for).
- Restoration of damaged parts, it necessary.

Medium repair-M

- All the operation of small repair but more number of units. Stocks as compared to the small repair are disassembled part wise, repair and re-assembled.
- Scraping/Grinding of the surface (if the wear exceeds of permissible limit).
- Painting of external unmachined surfaces of the machines.
- The machine after repair is checked as per “accuracy test charts”.

Complete overhaul-C

- All the operations of the medium repair, but each and every unit is disassembly part wise, most of the worn out parts replaced by new ones and machine assembled.
- Unchecked and repaired, if necessary.
- Grinding/scrapping of the surfaces.

Advantages of Preventive maintenance:

- Major repairs can be avoided.
- Gives less production down time.
- Product rejection is minimum.
- Provide better quality control facilities.
- Lengthen the life of equipment.
- Provides safety to the workers
- Minimum inventory control.

UNPLANNED MAINTENANCE:

The maintenance which is carried out immediately to avoid any serious consequences or failure is called unplanned maintenance. Some time is called as “Emergency Maintenance” Break Down Maintenance: This Break down Maintenance is only suitable for small scale industries, as it involves less direct cost and labour whereas large scale industries does not depend on this maintenance. The Breakdown maintenance does not provide any guarantee of reliability to the smooth production running. The maintenance work such as repairing, replacements are performed only when breakdown occurs. So there is loss of production and extensive damage to assists or equipment. It is better to avoid breakdown maintenance and go for planned maintenance.

Contract Maintenance:

Using outside man power, tools, equipments or consultancy to maintain printing equipment is called contract maintenance. Many of the printing plants utilize the outside personal repaired equipment, especially small scale industries, because they may not have any skilled person or any other reason relates to cost. But contract maintenance can be used by any industries of its size. Also contract maintenance can be done yearly, monthly etc., according to the press owner desire.

Advantages of Contract Maintenance:

- Capital Expenditures towards maintenance is reduced.
- No need to train or retain any workers.
- Control over the result.

Disadvantages of contract Maintenance:

- Possibility of a long delay in specialty arrival.
- More Expensive than integral maintenance.
- Problem with union, due to outride person service.
- Dependency upon the contracting company.

1.3 .1 PREVENTIVE MAINTENANCE FUNCTION

A maintenance system incorporates all functions like planning, scheduling, dispatching, recording, analysis and controlling.

PLANNING

Planning means formulation of word in advance. A successful maintenance depends on maintenance planning only. So “What should be done” and Where should be done” are the major criteria of successful maintenance.

Maintenance planning may be effectively performed, if the past data regarding inspecting etc, are available in the department. The best way is to have a “History card” for each machine or instrument. Analysis of the past data can only enable the management build a confident work-planning structure.

In case of a preventive maintenance, the total planning should be reflected in master card. After preparing “Master maintenance schedule”, weekly schedule may also be planned. But while planning, the activities required for an effective maintenance are to identify.

For example: cleaning, lubrication etc.

SCHEDULING

Scheduling is the time phase of the sequential activities. A maintenance schedule generally include activities,

- Inspection
- Repair (Major/minor repair)
- Overhauling

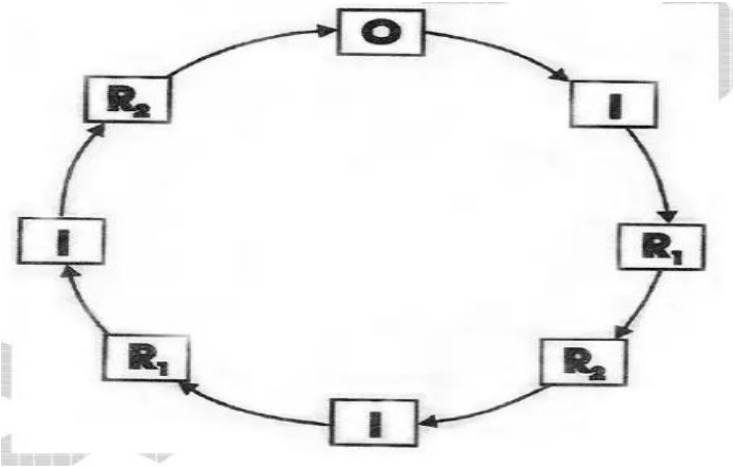


Fig 1.1 repair cycle

All the above activities are performed repetitively and the activities between two overhauling are termed as “repair cycle” and it is shown in diagram. In this diagram, the activity is started in a clockwise direction. It is seen that at first an inspection is scheduled, then a minor and a major is planned. Now again inspection is done and a minor repair is performed. After the third inspection a major repairing takes place and then next overhauling comes. That means completing one repair cycle. So from the above repair cycle we can state three-Inspections, two-minor & major repair are performed in between the two consecutive overhauling.

Now it is evident that the time period for a repair cycle is dependent on the time intervals between the two activities. If the Time interval is six month, and then the repair cycle is for four years.

The planning of time intervals may be considered by the past

Data of the machine, manufacturing instructions and complexities of the instruments etc

DISPATCHING

Once scheduling is completed, the next phase is dispatching, that is to issue order to start work. So maintenance authority issues “work order”.

ANALYSING

To evaluate the maintenance work done so far, a feed system is followed. In that system a “Work report” communicates, “What has been done” against our planned work schedule of “What to do” Analyzing of such report will enable the management to control and review the “Maintenance planning”.

CONTROLLING

To enjoy the full planning, a effective control system should be maintained. Whenever the plan deviates or does not occur as per schedule, a corrective measure is to be followed. For this, monitoring of the total project is carried out which provides information, if any change of action is to be made in course of work.

The maintenance work-order and work report may be checked and compared in course of work, whether the work has already been done, or work need is waiting for any spare or is facing any type of administrative of technical difficulties, are always to be monitored. The both way information line should exist with the superior personnel. If the work has been done satisfactorily, then it is recorded in equipment history card as shown in flow chart.

ADVANTAGES OF PREVENTIVE MAINTENANCE

1. Major repairs can be avoided.
2. Gives less production down time.
3. Product rejection is minimum.
4. Provides better quality control facilities.
5. Lengthens the life of equipments.
6. Provides safety to the workers
7. Minimum inventory control.

1.1.3 Safety

Personal protective equipment (PPE) is an important means of preventing work injuries. Ideally, the best approach is to maintain a safe work environment and eliminate any potential hazards.PPE should only be relied upon as a last line of defense in places where it is not practicable to control the hazards at source. The use of PPE generally implies working in a potentially hazardous work environment and its use is a major means of injury prevention. Therefore, it is of prime importance to ensure that the equipment chosen is both reliable and effective, it is being properly used and

maintained, and the user has undergone adequate training. The aim of this booklet is to raise the awareness of occupational safety and health practices and the proper use of PPE of people from all walks of life.

Key Points on the Proper Use of Personal Protective Equipment

1) **Proper selection**

You must first understand the nature and degree of the potential hazards, and then select appropriate PPE that meets the relevant standards. Furthermore, some PPE (such as breathing apparatus) must properly fit the physique of the user before they can be effective.

PPE must meet the demands of the work environment and should be as comfortable and easy to use as possible.

1. **Correct use**

You must fully understand and abide by the correct usage methods of the PPE.

Examples

Of incorrect use include different brands of filter being fitted to a respirator or the filters being cleaned with water.

2. **Correct maintenance**

PPE should be cleaned and dried after use, properly stored and regularly inspected. If you discover any damage to the PPE; you should immediately report this to your supervisor so that it can be replaced

Protective Clothing

Protective clothing provides physical protection and can increase comfort levels while on the job.

The following kinds of protective clothing are available, affording protection from different hazards:

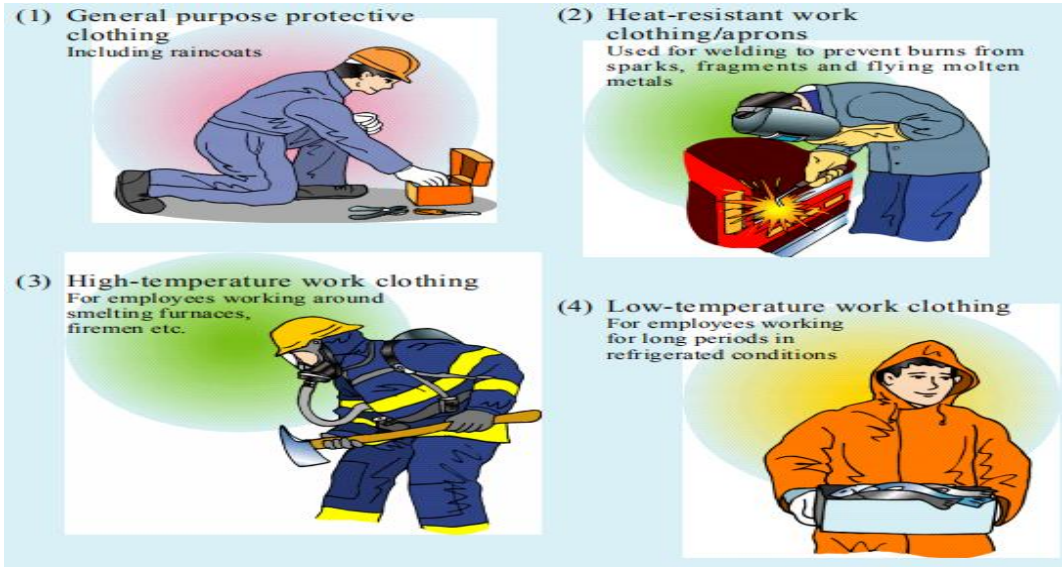


Fig 1.2 Protective Clothing

Protective Gloves

Using your hands is an almost indispensable part of any job and thus there is always the risk of getting your hands injured. You must therefore select appropriate hand protection. Furthermore, if your hands are likely to come into contact with harmful or corrosive chemicals resulting in rashes or skin inflammations, products such as protective ointments can be used to provide extra protection. The regulations also expressly state that proprietors shall provide sufficient supply of protective skin ointments to workers involved in electrolytic chromium processes.

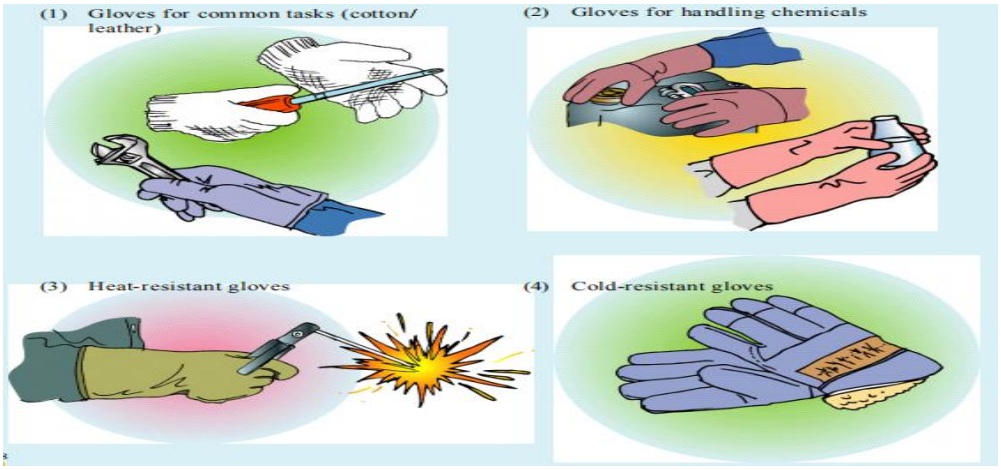


Fig1. 3 Protective Gloves

Eye Protectors

Our eyes are highly susceptible to injury from external hazards that can lead to partial or complete blindness. The "Factories and Industrial Undertakings (Protection of Eyes)

Regulations" state that proprietors must provide suitable eye protection to employees undertaking certain processes and to others affected by those processes.

Fig1. 4 Eye Goggles

Safety Footwear

Accident statistics from the Labour Department reveal that there are many accidents annually caused by stepping on objects and slips. So how can we reduce the risk of foot injuries to employees? Wearing appropriate safety foot wear is one of the easy and effective ways

Fig1. 5 Safety Footwear

Dust mask: Wearing a **mask** at work is no luxury, definitely not when coming into contact with hazardous materials. 15% of the employees within the EU inhale vapours, smoke, powder or dusk while performing their job. **Dust masks** offer protection against fine dust and other dangerous particles. If the materials are truly toxic, use a **full-face mask**. This adheres tightly to the face, to protect the nose and mouth against harmful pollution.

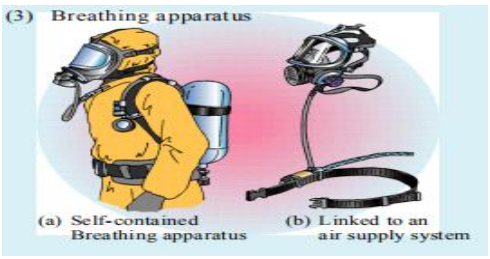


fig 1.6a) breathing apparatus

fig1.6 b) air-purifying respirators

Identifying Maintenance Hazards

The hazards associated with maintenance activities can be classified as follows:

Safety Hazards

- **Mechanical**
  - ✓ equipment and tools
- **Electrical**
  - ✓ live equipment
- Pneumatic
- Hydraulic
- Thermal
- Combustion
- Falls
  - ✓ slippery floors
  - ✓ working at heights

Health Hazards

- Chemical Agents
  - ✓ process chemicals
  - ✓ cleaning solvents
  - ✓ unexpected reaction products
  - ✓ dusts
  - ✓ other chemical agents
- Physical Agents
  - ✓ Noise
  - ✓ Vibration
  - ✓ Others

Many of these hazards are interrelated. Examine your process, the layout of your process area, and the process equipment used, to determine the exact nature of the hazards likely to be encountered during your maintenance activities. For example, maintenance work carried out in confined spaces carries a greater risk of critical injuries

and acute exposures to chemical and physical agents. These risks are associated with equipment and materials in the space itself and from nearby operations. Fatalities are quite common.

1.1.4 SAFETY PRECAUTIONS & HOUSEKEEPING PROCEDURESSAFETY PRECAUTIONS

1. Exercise extreme care and precaution when working on any printing press
2. Observe and practice all safety rules, regulations, and advice given in the press manual.
3. Head all verbal and written instructions before performing maintenance or operating the press.
4. Wear protective gear for eyes, ears, head, and feet where necessary to protect against injury
5. Stand clear of the press immediately when the run signal is given
6. Make sure the press is completely stopped before touching any of its operating parts
7. Check all safety devices on the press every day to ensure that they are reliable and working
8. Never switch off safety devices or remove or otherwise bypass guards.
9. Before working on the press, check to make sure it has been put on “safe” using the “stop (security)” push button and follows the proper lockout/tag out procedures where necessary to ensure the safety of everyone involved in press maintenance.
10. Check that stairs, footrests, running bolts, gangways, plat forms, and other equipment surfaces are clean and free of grease. Do not place tools and supplies on these surfaces.
11. Grasp handrails securely when ascending the platforms, standing on the platforms, and before leaving the platforms.
12. Only clean the ink foundations while the press is stopped to avoid injury and press damage.
13. Do not work on moving rollers with rags, tolls etc., because of the risk of accident and damage.
14. Reinstall guards immediately after removing the press wash-up devices.
15. Use the “reverse” button on the press only for plate removal-not for cleaning or gumming cylinders, etc.
16. Do not operate equipment unless authorized.
17. Check that all guards and shields are in place before operating the press.
18. Never release a safe button that someone else has set.
19. .Do not start a press that has stopped without an apparent reason.
20. Wear a gearing protection device when working in areas with noise levels.

21. Check that all guards, covers and swiveling footrests are securely fastened or completely locked in place before performing maintenance or operating the press
22. Check for persons, tools, or equipment between and around the press before starting it.
23. Remove all used plates, tools, and equipment from the press area and alert your co-workers before starting the press.
24. Wear a hearing protection device when working in areas with high noise levels.
25. Do not permit people with jewelry, loose clothing, or long hair in the pressroom.
26. Do not lean or rest hands on the press.
27. Do not carry tools in pockets to avoid the possibility of dropping them into the press or other hazardous locations.
28. When making press adjustments, use only recommended tools that are kept in good working condition.
29. Keep clear of nips, slitters, and moving parts when performing maintenance or operating the press.
30. To perform any cleaning process, use rags folded into a pad with no loose edges dangling.
31. Keep a complete and accessible file of all service manuals, instruction manuals, parts lists, and lubrication manuals or charts for each piece of equipment in the pressroom.
32. Never make repairs and adjustments or perform maintenance and cleaning jobs when the machine is running. Any work of on the press, under the in feed mechanism, around the folder, on the motor, on the main control panel, or on the other electrical or moving parts of the equipment must be performed only if the main switches ON the control panel are in the OFF position, and locked or tagged out

HOUSEKEEPING

Introduction

In industry 'housekeeping' is not just a push-broom effort. Housekeeping means much more than that. It means not only cleanliness.

But also an orderly arrangement of operations, tools equipment, storage facilities and supplies. It is a practical method of increasing production, reducing accident and improving morale and public relations.

Typical Accidents due to poor House keeping

The relationship between accidents and poorhouse keeping is very close indeed as will be evident from careful analysis of accidents in any factory. To often accidents are reported because of:

I. Men tripping over loose objects on floors, starts, and platforms

II. Men getting hit by article falling from overhead
III. Men slipping on greasy wet or dirty floors.
IV. Men running against or projecting, poorly piled or poorly placed materials
V. Men getting trapped under materials falling from piles improperly built
VI. Men stepping on or tearing hands or other parts of the body on Projecting nails or hooks.

Typical Items of Unsafe Housekeeping

Good housekeeping cannot be attained by an occasional grand clean up and setting in order. It must be planned for and continuously pushed. To plan effectively, typical items, which render a work place, unsafe must be recognized. Some of the common unsafe housekeeping items:

1. Excessive material, waste, or debris in the work area
2. Congested aisles
3. Overloaded waste containers
4. Disorderly kept locker and washrooms
5. Dirty walls, ceiling &windows
6. Lint and dust on bearing or machines
7. Tools left on machines
8. Poor lighting
9. Acids in open containers
10. Electric wires, cables and hoses across aisles

Spillage of oil, grease, storage areas etc not properly marked Once the items, which are responsible for rendering a workplace unsafe, are recognized, it becomes easier to plan for good housekeeping.

Aid to good housekeeping:

Achieving orderliness and cleanliness does not come from wishing. Certain policies must be established and equipment necessary for good housekeeping must be provided. In general orderliness and cleanliness in a plant pre supposes that management has arranged for the following at least.

1. Proper layout of work area
2. The marking of aisles and storage areas
3. Cabinets and holders for tools and portable equipment
4. Storage and arrangements for materials
5. Efficient sequence of operations to avoid bottlenecks
6. Efficient transportation of the raw material, the finished product and the refuse

7. Efficient cleaning methods such as use of vacuum cleaners and scientific scheduling of cleaners without interference with production schedule
8. Careful training of employees.

Many more items can be added to the above list. With these listed aids available, it should not be too much of a problem to the foreman to keep his house clean can orderly with a place for everything in its place.

THE 5S's: THE FIVE STEPS OF HOUSEKEEPINGGOOD HOUSEKEEPING

The five steps of housekeeping, with their Japanese names, are as follows:

1. **Seiri:** Distinguish between necessary and unnecessary items in gemba and discard the latter.
2. **Seiton**: arrange all items remaining after seiri in an orderly manner.
3. **Seiso:** Keep machines and working environments clean.
4. **Seiketsu:** Extend the concept of cleanliness to oneself and continuously practice the above three steps.
5. **Shitsuke:** Build self-discipline and make a habit of engaging in 5sby establishing standards.

In introducing housekeeping, Western companies often prefer to use English equivalents of the five Japanese S's as in a "Five-S's campaign".

A FIVE-S's CAMPAGIN

1. **Sort:** Separate out all that is unnecessary and eliminate it.
2. **Straighten:** Put essential things in order to so that they can be easily accessed.
3. **Scrub:** Clean everything-tools and workplaces –removing stains, spots, and debris and eradicating sources of dirt.
4. **Systematize:** Make cleaning and checking routine.
5. **Standardize:** standardize the previous four steps to make the process one that never end and can be improved upon.

Preventive Maintenance Tools and Equipment Tools: is necessary for PM operations must be available for use. No general list of tools will apply to all installations as each facility will have certain requirements according to its equipment types. Review the PM operations for each facility to determine the tools required for these operations.

1.1.2 Preparing equipment for preventive maintenance

1.1.2.1 Photo copy machine

A photocopier (also known as a copier or copy machine) is a machine that makes copies of documents and other visual images onto paper or plastic film quickly and cheaply.

A **photocopier** (also known as **copy machine** or **copier**) was first introduced by Xerox in 1959. It is a machine that produces paper copies of text documents, photos, or illustrations. Most modern photocopiers use a technology called xerography, a method that uses electrostatic charges on a light sensitive photoreceptor to attract and lay down toner to paper. Heat, pressure or both are then used to meld the toner onto the paper creating a visible image.

Photocopying machine also called **Photocopier**, any device for producing copies of text or graphic material by the use of light, heat, chemicals, or electrostatic charges. The need for a process other than wet photographic reproduction for copying documents stimulated the invention of various techniques, notably the diffusion-transfer and dye-line processes, during the early 1950s. In the diffusion-transfer process a master copy is made on a translucent sheet, which is placed on light-sensitized negative paper and exposed to light. The negative is then placed in contact with a sheet of positive transfer paper and fed into a developer. When the two sheets are peeled apart, the image is transferred to the positive paper. The dye-line process also requires a translucent original but only one sheet of sensitized paper. This process uses ammonia fumes rather than liquid to develop the image, obviating problems of paper shrinkage.

IMAGE FORMATION SYSTEM

The image forming process is divided into the eight steps shown below.

Step 1: Pre-exposure

Step 2: Primary corona (negative DC)

Step 3: Image exposure

Step 4: Developing (positive plus AC)

Step 5: Transfer (negative DC)

Step 6: Separation

Step 7: Fixing

Step 8: Drum cleaning

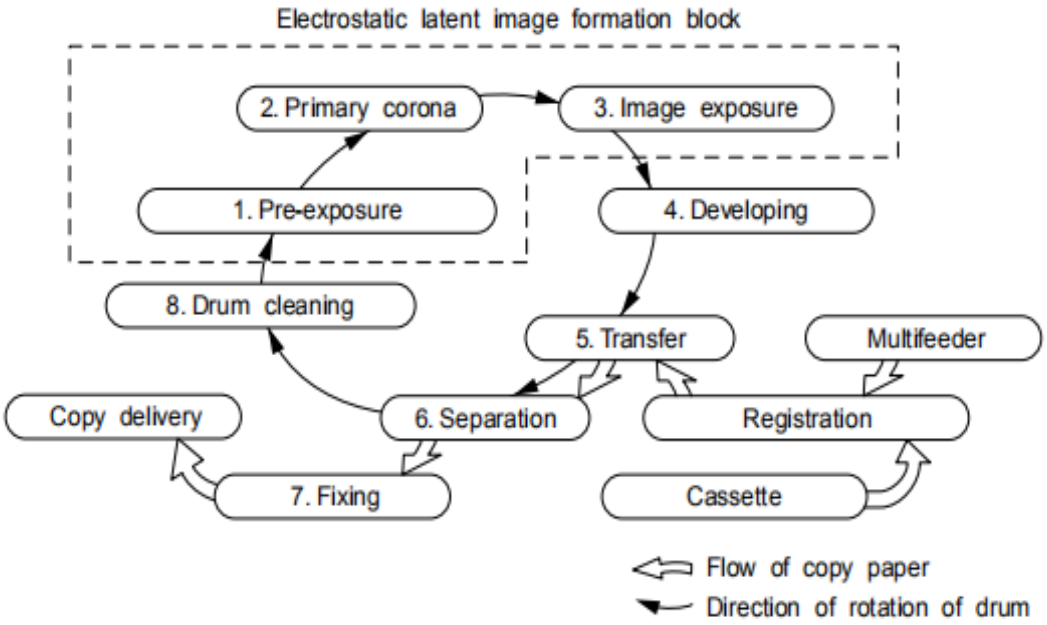


Fig 1.7 image forming process

- **Charge.** Inside every copier and laser printer is a light-sensitive surface called a photoreceptor it consists of a thin layer of photoconductive material that is applied to a flexible belt or drum. The photoreceptor is insulating in the dark, but becomes conducting when it is exposed to light. It is charged in the dark by applying a high DC voltage to adjacent wires, which produces an intense electric field near the wires that causes the air molecules to ionize. Ions of the same polarity as the voltage on the wires deposit on the photoreceptor's surface, creating an electric field across it.
- **Expose.** In a digital copier or printer, the image is exposed on the photoreceptor with a scanning modulated laser or a light-emitting-diode image bar. In older analog copiers, reflected light from an illuminated image is projected onto the photoreceptor. In either case, the areas of the photoreceptor exposed to light are selectively discharged, causing a reduction in the electric field. The darker areas retain their charge.
- **Develop.** Pigmented powder used to develop the image is called toner. Toner particles made of colorant and plastic resin have precisely controlled electrostatic properties and range from about five to 10 micrometers in diameter. They are mixed with and charged by magnetized carrier beads that transport them to the development zone. The particles are charged by the phenomenon of triboelectricity (often referred to as static electricity). The electric field associated with the charge pattern of the image on the photoreceptor exerts an electrostatic

force on the charged toner, which adheres to the image. A color document is formed by a printer with four separate xerographic units that create and develop separate cyan, magenta, yellow and black images. The superposition of these powder images produces full-color documents.

- **Transfer.** The powder image is transferred from the photoreceptor onto paper by bringing the paper in contact with the toner and then applying a charge with polarity opposite to that of the toner. The charge must be strong enough to overcome the powders adhesion to the photoreceptor. A second precisely controlled charge releases the paper, now containing the image, from the photoreceptor.
- **Fuse.** In the fusing process, the toner comprising the image is melted and bonded to the paper. This is accomplished by passing the paper through a pair of rollers. A heated roll melts the toner, which is fused to the paper with the aid of pressure from the second roll.
- **Clean.** Toner transfer from the photoreceptor to the paper is not 100 percent efficient, and residual toner must be removed from the photoreceptor before the next print cycle. Most medium- and high-speed copiers and printers accomplish this with a rotating brush cleaner.

Printer

A printer is an external output device that takes data from a computer and generates output in the form of graphics / text on a paper.

There are two types of printers.

1.1.2.2 Impact printers

An impact printer makes contact with the paper. It usually forms the print image by pressing an inked ribbon against the paper using a hammer or pins. Following are some examples of impact printers.

Dot-Matrix Printers

The dot-matrix printer uses print heads containing from 9 to 24 pins. These pins produce patterns of dots on the paper to form the individual characters. The 24 pin dot-matrix printer produces more dots that a 9 pin dot-matrix printer, which results in much better quality and clearer characters. The general rule is: the more pins, the clearer the letters on the paper. The pins strike the ribbon individually as the print mechanism moves across the entire print line in both directions, i.e. from left to right, then right to left, and

so on. The user can produce a color output with a dot-matrix printer (the user will change the black ribbon with a ribbon that has color stripes). Dot-matrix printers are inexpensive and typically print at speeds of 100-600 characters per second.

Fig 1.9 Dot-Matrix Printers

Daisy-wheel printers

In order to get the quality of type found on typewriters, a daisy-wheel impact printer can be used. It is called daisy-wheel printer because the print mechanism looks like a daisy; at the end of each “Petal” is a fully formed character which produces solid-line print. A hammer strikes a “petal” containing a character against the ribbon, and the character prints on the paper. Its speed is slow typically 25-55 characters per second.

Line printers

In business where enormous amount of material are printed, the character-at-a-time printers are too slow; therefore, these users need line-at-a-time printers. Line printers, or line-at-a-time printers, use special mechanism that can print a whole line at once; they can typically print the range of 1,200 to 6,000 lines per minute. Drum, chain, and band printers are line-at-a-time printers.

Drum printer

A drum printer consists of a solid, cylindrical drum that has raised characters in bands on its surface. The number of print positions across the drum equals the number available on the page. This number typically ranges from 80-132 print positions. The drum rotates at a rapid speed. For each possible print position there is a print hammer located behind the paper. These hammers strike the paper, along the ink ribbon, against the proper character on the drum as it passes. One revolution of the drum is required to print each line. This means that all characters on the line are not printed at exactly the same time, but the time required to print the entire line is fast enough to call them line printers. Typical speeds of drum printers are in the range of 300 to 2000 lines per minute.

Chain printers

A chain printer uses a chain of print characters wrapped around two pulleys. Like the drum printer, there is one hammer for each print position. Circuitry inside the printer detects when the correct character appears at the desired print location on the page. The hammer then strikes the page, pressing the paper against a ribbon and the character located at the desired print position. An impression of the character is left on the page. The chain keeps rotating until all the required print positions on the line have filled. Then the page moves up to print the next line. Speeds of chain printers range from 400 to 2500 characters per minute.

Band printers

A band printer operates similar to chain printer except it uses a band instead of a chain and has fewer hammers. Band printer has a steel band divided into five sections of 48 characters each. The hammers on a band printer are mounted on a cartridge that moves across the paper to the appropriate positions. Characters are rotated into place and struck by the hammers. Font styles can easily be changed by replacing a band or chain.

1. **Non-impact printers**

Non-impact printers do not use a striking device to produce characters on the paper; and because these printers do not hammer against the paper they are much quieter. Following are some non-impacted printers.

Ink-jet printers

Fig 1.10 Ink-jet printers

Ink-jet printers work in the same fashion as dot-matrix printers in the form images or characters with little dots. However, the dots are formed by tiny droplets of ink. Ink-jet printers form characters on paper by spraying ink from tiny nozzles through an electrical field that arranges the charged ink particles into characters at the rate of approximately

250 characters per second. The ink is absorbed into the paper and dries instantly. Various colors of ink can also be used.

One or more nozzles in the print head emit a steady stream of ink drops. Droplets of ink are electrically charged after leaving the nozzle. The droplets are then guided to the paper by electrically charged deflecting plates [one plate has positive charge (upper plate) and the other has negative charge (lover plate)]. A nozzle for black ink may be all that's needed to print text, but full-color printing is also possible with the addition of needed to print text, but full-color printing is also possible with the addition three extra nozzles for the cyan, magenta, and yellow primary colors. If a droplet isn't needed for the character or image being formed, it is recycled back to its input nozzle.

Several manufacturers produce color ink-jet printer. Some of these printers come with all their color inks in a cartridge; if you want to replace on color, you must replace all the colors. Other color ink-jet printers allow you to replace ink individually. These printers are a better choice if user uses one color more than other colors. These printers produce less noise and print in better quality with greater speed.

Laser printers

Fig 1.11 Laser printers

A laser printer works like a photocopy machine. Laser printers produce images on paper by directing a laser beam at a mirror which bounces the beam onto a drum. The drum has a special coating on it to which toner (an ink powder) sticks. Using patterns of small dots, a laser beam conveys information from the computer to a positively charged drum to become neutralized. From all those areas of drum which become neutralized, the toner detaches. As the paper rolls by the drum, the toner is transferred to the paper

printing the letters or other graphics on the paper. A hot roller bonds the toner to the paper.

Laser printers use buffers that store an entire page at a time. When a whole page is loaded, it will be printed. The speed of laser printers is high and they print quietly without producing much noise. Many home-use laser printers can print eight pages per minute, but faster and print approximately 21,000 lines per minute, or 437 pages per minute if each page contains 48 lines. When high speed laser printers were introduced they were expensive. Developments in the last few years have provided relatively low-cost laser printers for use in small businesses.

Advantages of Laser Printer

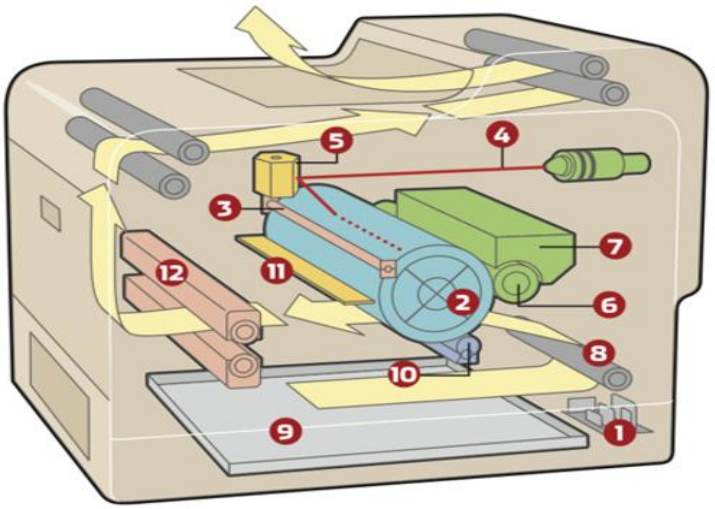
- The main advantage of Laser printer is its speed & efficiency at which it prints high-quality quality graphics & text.
- Laser printers produce high-quality output as compared to other printers.
- Laser printers are quite and does not produce disturbing sounds.
- They are also capable to produce color prints.

Disadvantages of Laser Printer

- The main disadvantage of Laser printer is its cost, they are relatively costly as compared to other printers.
- The maintenance, repair & servicing charges are also high of these printers.
- Laser printers emit small amount of ozone and are hazardous to health and the atmosphere.

Image formation system of laser printer

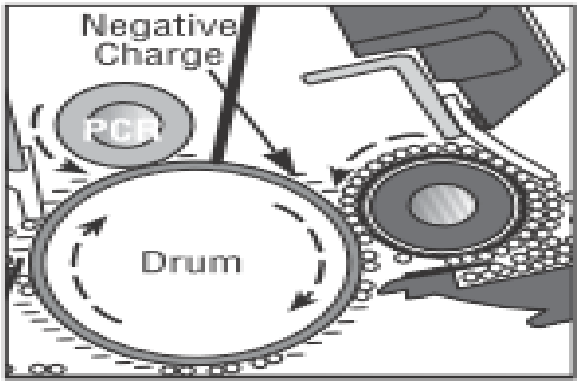
Laser Printer Parts



(1) controller circuitry
(2) photo conductor drum
(3) charge roller
(4) laser beam
(5) rotating mirror
(6) developer roller
(7) toner hopper
(8) roller assembly
(9) paper tray
(10)transfer roller
(11)cleaning blade
(12)fuser

Fig1.12 **Laser Printer Parts**

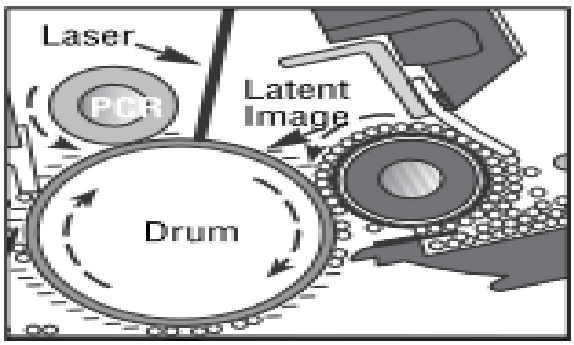
Step1: Charging



The process begins with the charging of the organic photo conductor (OPC drum) by the primary charge roller (PCR). A constant flow of electrical current from the PCR produces an even blanket of negative charge on the surface of the rotating drum.

Fig1.13 Charging

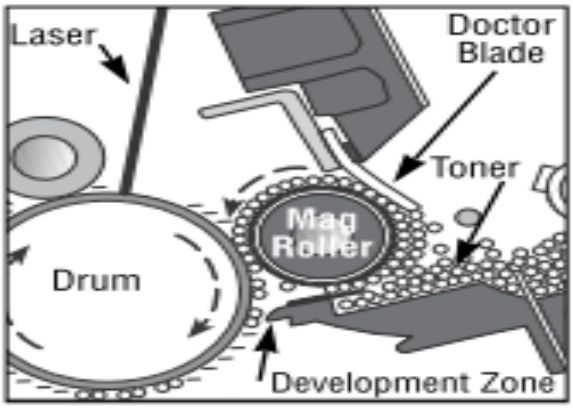
Step2: Exposure



The laser passes through an opening in the cartridge and focuses on the evenly charged drum surface. As the drum rotates the focused beam of the laser scans across the drum, emitting light and discharging the drum in the pattern of the image and/or characters to be printed. This "writing to the drum" leaves a positively charged latent image on the drum surface (it's there, but you can't see it yet).

Fig1.14 Exposure

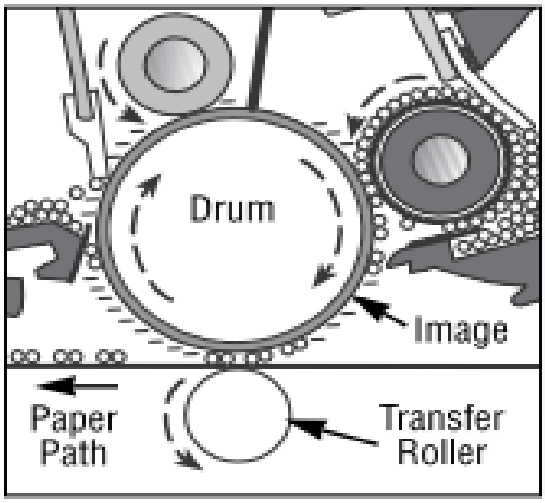
Step3: Development



There is a small gap between the doctor blade and the magnetic developer roller (mag roller). The rub results in a **negative** charge build-up on the individual toner particles.
Since both the toner and mag roller are charged negatively the toner is repelled (pushed) toward the positively charged areas of the drum (the latent image).

Fig 1.15 Development

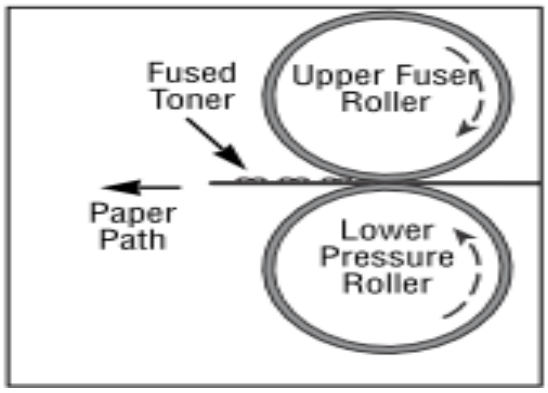
Step4: Transferring



The transfer roller, which carries a positive charge, is located inside the printer and is not a part of the cartridge. The paper travels on a path between the OPC drum and this roller. The toner-covered image on the surface of the drum is moved down toward the paper by the rotation of the drum. The **positive** charge of the transfer roller attracts the negatively charged toner, pulling it off the drum and down onto the paper.

Fig 1.17 Transferring

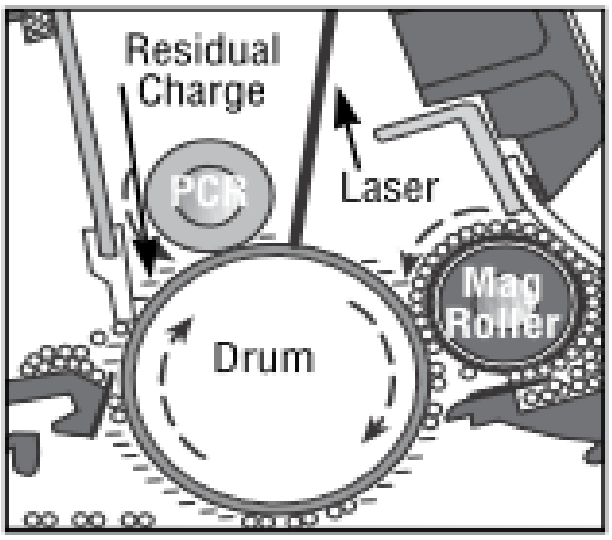
Step 5: Fusing



Here it becomes sandwiched between the fuser assembly, composed of an upper fuser roller and a lower pressure roller. Heat is applied by the upper roller, fusing the toner into the paper, while the lower roller applies pressure, imbedding the toner into the paper fibers.

Fig1.18 **Fusing**

Step 7: Erasure



The PCR “erases” any remaining positive charge from the OPC drum by applying a uniform negative surface charge to the drum. This removes the image and cleans, or “blanks” the drum for its next pass under the laser, where it will be written with the next image.

Fig 1.19 ***Erasure***

1.1.2.3 Fax machine

What is a Fax Machine?

A fax machine is a device that is used to send documents electronically over a telephone network. The transmissions it sends are called “faxes,” and these can be between two fax machines, or between a fax machine and computer or online fax service that is equipped to send and receive faxes.

A fax machine is designed to both send and receive documents so it has a sending part and a receiving part. The sending part is a bit like a computer scanner, with a **CCD** (charged-coupled device) that scans only one line of a document at a time, and only in black and white. Crudely simplified, it looks at each line separately, detects the black areas and the white areas, and transmits one kind of electric pulse down the phone line to represent black and another to represent white (just like saying "black" and "white", in fact). The phone line transmits this information almost instantly to a fax machine at the other end. It receives the electrical pulses and uses them to control a printer. If the receiving fax hears "black", it draws a tiny black dot on the page; if it hears white, it moves along slightly, leaving a white space instead. It takes about a minute or so to transmit a single page of writing (or a complex drawing) in this clumsy but very systematic way.

What happens inside a fax machine?

Ever wondered what goes on inside your machine when you send or receive a fax?

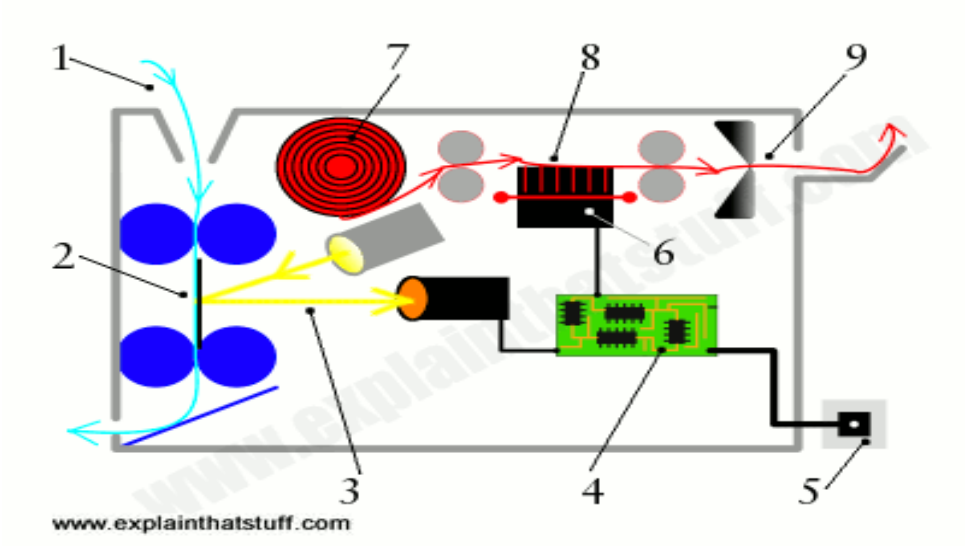


Fig 1.20 sends and receives process

1. To send a fax, you feed the page into the input slot and it's pulled in between several pairs of rollers. Larger fax machines have built-in document feeders that automatically feed in multiple pages from a stack, so you don't have to stand at the machine feeding in pages one at a time.
2. As the paper moves down, a bright light shines onto it. White areas of the page reflect a lot of light; black areas reflect little or none.
3. The light reflects off the page into a light-detecting CCD (charged-coupled device).
4. The CCD turns the analog pattern of black and white areas on the page into a numeric (digital) pattern of binary zeros and ones and passes the information to an electronic circuit.
5. The circuit sends the digital information down the telephone line to the fax machine at the receiving end.
6. When you receive a fax, the same circuit takes incoming digital information from the phone line and routes it to a built-in printer.
7. In a typical personal fax machine, paper is pulled from a large roll inside the machine. (In a larger office fax machine, it usually comes from a plain-paper hopper, similar to the one in a laser printer.)
8. The thermal (heat-based) printer, operated by the circuit, reproduces the incoming fax on the paper as it moves past.
9. An automatic blade cuts the page and the printed fax emerges from the output slot.

1.1.2.3 Scanner

What is scanner?

A scanner is an input device that captures documents such as photographs and text. Scanners are of many types according to their design, scanning mechanisms etc. When a document is to be scanned, firstly a documents is converted into digital signal and then scanning is performed on this electronic version of document.

A scanner can be connected to computer using different interface such as SCSI, TWAIN etc, but today the most common method is USB cable.

TYPES OF SCANNER

FLATBED SCANNER

Flatbed scanners will take up some desktop space but provide a lot of bang for the buck. They look like miniature printers with a flip-up cover protecting the glass platen. Flatbed scanners are some of the most commonly used scanners as it has both home and office functions. The way they scan documents is that a mechanism rolls under the document to obtain the image. For businesses that have a need for high processing abilities, the flatbed scanner can scan any number of documents with a click of a button.

SHEET-FED SCANNER

Sheet-fed scanner is smaller in size than flatbed scanner. This type of scanner works like a flatbed scanner except that the document is fed through the scanner and moves along the beam to be read rather than the beam moving along document. This type is not useful for books, but only single sheets.

A small size is its advantage but improper mechanism can skew the paper.

DRUM SCANNER

Drum scanner is used for scanning a document and produce at very high resolution rate. There is no any type of scanner that will give you the kind of resolution, detail, sharpness, dynamic range, and color rendition that drum scanning can give you. There are only a few companies that make these scanners, considering the high cost of producing a scanner such as this. It is considered as a tremendous upgrade to a regular flatbed scanner.

A drum scanner uses a photo-multiplier (PM) tube, which is a light sensing device. That's why it offers a high sensitivity and good signal-to-noise ratio. The image to be scanned is placed on spinning.

HANDHELD SCANNER

Handheld scanner is much like a flatbed scanner. Handheld scanners are small helpful electronic devices that are widely used for digitizing printed documents. Handheld scanner provides lower quality scanners; they are still very popular because they are small and less expensive than their flatbed. They are able to scan items that could not fit in a flatbed scanner due to size or location. Their function includes moving them over the material being captured with the aid of a tray to keep it in a straight line. Experience is required to operate and handle the device since it is very important to keep the scanner straight so that a distortion-free scan is possible.

Fig 1.21 Microtek's Scan maker flatbed scanner

The basic principle of a scanner is to analyze an image and process it in some way. Image and text capture (optical character recognition or OCR) allow you to save information to a file on your computer. You can then alter or enhance the image, print it out or use it on your Web page. In this article, we'll be focusing on flatbed scanners, but the basic principles apply to most other scanner technologies. You will learn about the different types of scanners, how the scanning mechanism and works. You will also learn about resolution, interpolation and bit depth.

Anatomy of a Scanner

Parts of a typical flatbed scanner include:

- Charge-coupled device (CCD) array
- Mirrors
- Scan head
- Glass plate
- Lamp
- Lens
- Cover
- Filters
- Stepper motor

- Stabilizer bar
- Belt
- Power supply
- Interface port(s)
- Control circuitry

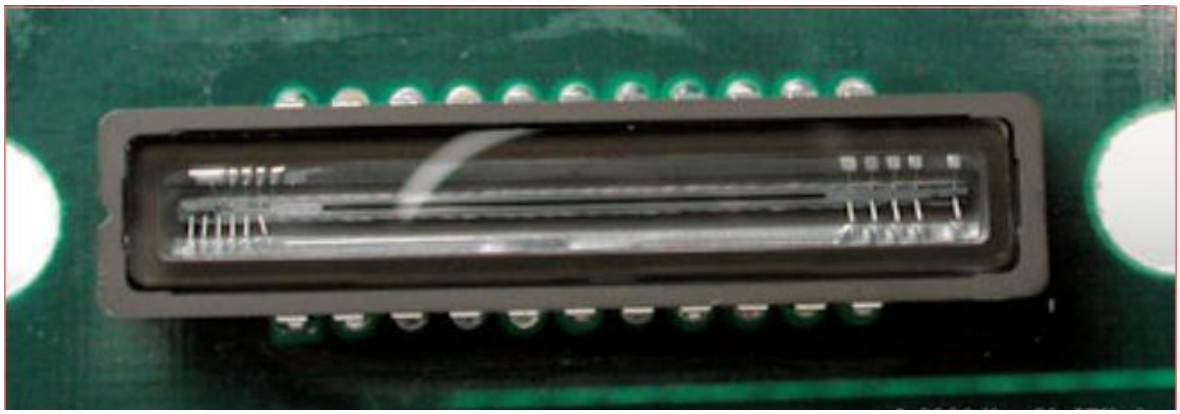


Fig 2.22 Close-up of the CCD array

The core component of the scanner is the CCD (charge couple device) array. CCD is the most common technology for image capture in scanners. CCD is a collection of tiny light-sensitive diodes, which convert photons (light) into electrons (electrical charge). These diodes are called photosites. In a nutshell, each photosite is sensitive to light -- the brighter the light that hits a single photosite, the greater the electrical charge that will accumulate at that site.

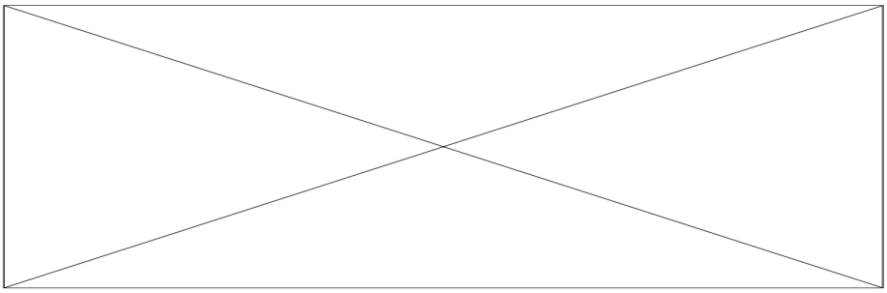


Fig 1.23 Photons hitting a photosite and creating electrons

The image of the document that you scan reaches the CCD array through a series of mirrors, filters and lenses. The exact configuration of these components will depend on the model of scanner, but the basics are pretty much the same.

The Scanning Process

Here are the steps that a scanner goes through when it scans a document:

- The document is placed on the glass plate and the cover is closed. The inside of the cover in most scanners is flat white, although a few are black. The cover

provides a uniform background that the scanner software can use as a reference point for determining the size of the document being scanned. Most flatbed scanners allow the cover to be removed for scanning a bulky object, such as a page in a thick book.

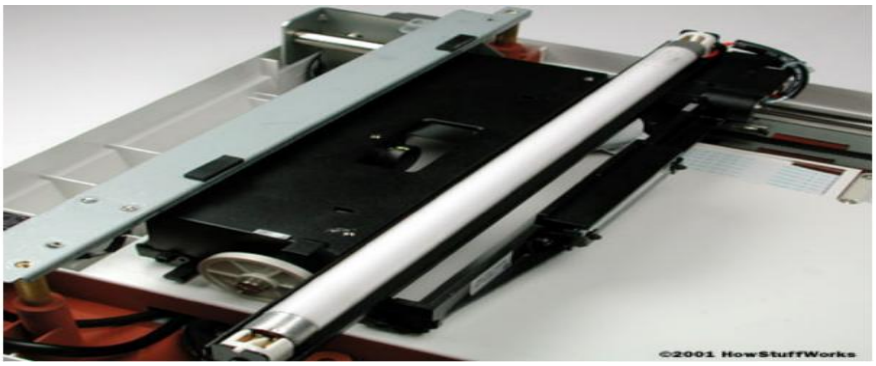


Fig1.24 shows In the image above, you can see the fluorescent lamp on top of the scan head.

- **A lamp** is used to illuminate the document. The lamp in newer scanners is either a cold cathode fluorescent lamp (CCFL) or a xenon lamp, while older scanners may have a standard fluorescent lamp.
- The entire mechanism (mirrors, lens, filter and CCD array) make up the scan head. The scan head is moved slowly across the document by a **belt** that is attached to a **stepper motor**. The scan head is attached to a **stabilizer bar** to ensure that there is no wobble or deviation in the pass. **Pass** means that the scan head has completed a single complete scan of the document.

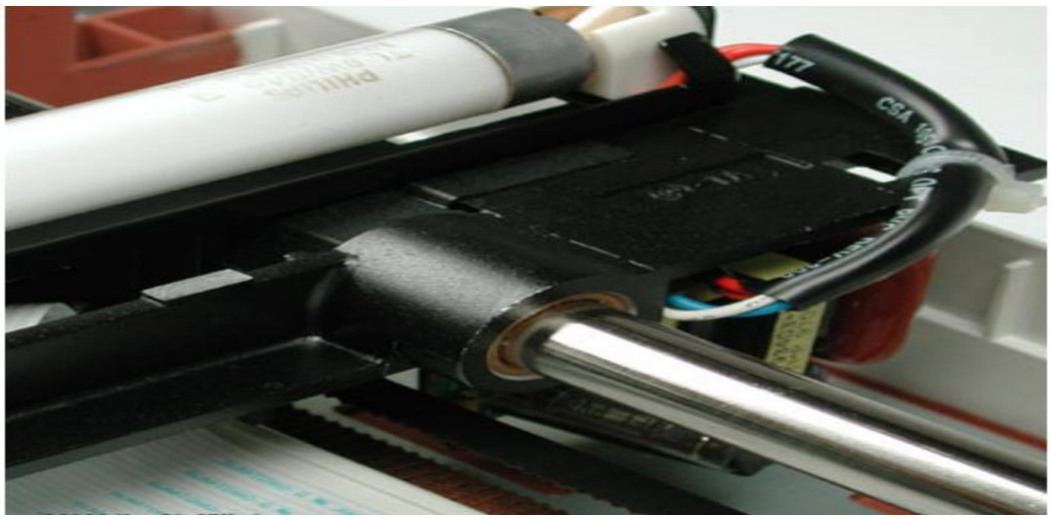


Fig 1.25 The stabilizer bar is very durable and tightly secured to the body of the scanner.

The image of the document is reflected by an angled mirror to another mirror. In some scanners, there are only two mirrors while others use a three mirror approach. Each mirror is slightly curved to focus the image it reflects onto a smaller surface. The last mirror reflects the image onto *a* lens. The lens focuses the image through a filteron the CCD array.

Fig1.26 Look carefully at the image above and you can see all three of the mirrors plus the lens assembly in this scan head.

The filter and lens arrangement vary based on the scanner. Some scanners use a three pass scanning method. Each pass uses a different color filter (red, green or blue) between the lens and CCD array. After the three passes are completed, the scanner software assembles the three filtered images into a single full-color image.

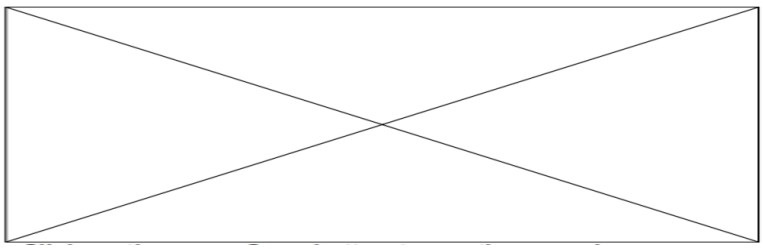


Fig 1.27 Click on the green Scan button to see the scanning process.

Most scanners today use the single pass method. The lens splits the image into three smaller versions of the original. Each smaller version passes through a color filter (either red, green or parts of the CCD array into a single full-color image.

Another imaging array technology that has become popular in inexpensive flatbed scanners is contact image sensor (CIS). CIS replaces the CCD array, mirrors, filters, lamp and lens with rows of red, green and blue light emitting diodes (LEDs). The image sensor mechanism, consisting of 300 to 600 sensors spanning the width of the scan area, is placed very close to the glass plate that the document rests upon. When the image is scanned, the LEDs combine to provide white light. The illuminated image is then captured by the row of sensors. CIS scanners are cheaper, lighter and thinner, but do not provide the same level of quality and resolution found in most CCD scanners.

Resolution and Interpolation

Scanners vary in resolution and sharpness. Most flatbed scanners have a true hardware resolution of at least 300x300 dots per inch (dpi). The scanner's dpi is determined by the number of sensors in a single row (x-direction sampling rate) of the CCD or CIS array by the precision of the stepper motor (y-direction sampling rate).

Fig1.28 The precision of the stepper motor determines the y-direction Sampling rate

For example, if the resolution is 300x300 dpi and the scanner is capable of scanning a letter sized document, then the CCD has 2,550 sensors arranged in each horizontal row. A single-pass scanner would have three of these rows for a total of 7,650 sensors. The stepper motor in our example is able to move in increments equal to 1/300ths of an inch. Likewise, a scanner with a resolution of 600x300 has a CCD array with 5,100 sensors in each horizontal row.

- Universal Serial Bus (USB) - USB scanners combine good speed, ease of use and affordability in a single package.
- FireWire - Usually found on higher-end scanners,FireWire connections are faster than USB and SCSI. FireWire is ideal for scanning high-resolution images.

Fig 1.29 scanner may have more than one way of connecting to your computer.

*On your computer, you need software, called a **drive**r that knows how to communicate with the scanner.*

1.1.2.4 What is a personal Computer (PC)?

A computer is an electronic device that manipulates information, or "data." It has the ability to store, retrieve, and process data. You can use a computer to type documents, send email, and browse the internet. You can also use it to handle spreadsheets, accounting, database management, presentations, games, and more.

Computers Simplified

For beginning computer users, the computer aisles at an electronics store can be quite a mystery, not to mention overwhelming. However, computers really aren't that mysterious. All types of computers consist of two basic parts:

- **Hardware** is any part of your computer that has a physical structure, such as the computer monitor or keyboard.

Fig 1.30 a) A desktop computers

Fig1.30 b)A motherboard (hardware)

Hardware Components

Case/ System Unit. The computer case (also called a tower) is the box that encloses many of the parts/components of the computer

Power Supply or SMPS(Switched Mode Power Supply). Converts AC voltage from the wall outlet to DC voltage the computer can use. It supplies DC voltages for internal computer components and has a fan to keep the computer cool.

Processor & Fan. The processor is the main "brain" of a computer system while the Fan help to prevent overheating of the various electronic components

Motherboard. The motherboard is a large electronic board that is used to connect the power supply to various other electronic parts, and to hold these parts in place on the computer.

RAM (Random Access Memory
- short term memory that is used to store documents while they are being processed.
- The amount of RAM in a computer determine the speed of a computer.
- RAM attaches to the motherboard via some specific slots.

NIC (Network Interface Card) used to describe tools that allow your computer to connect and communicate with various input and output devices.

Computer Hardware Repair and Maintenance 10

Fig 1.31 hardware parts

1.1.2.5 Uninterruptible Power Supply (UPS)

What is a UPS?

Put simply, a UPS is a device that:

1. Provides backup power when utility power fails, either long enough for critical equipment to shut down gracefully so that no data is lost, or long enough to keep required loads operational until a generator comes online.

2. Conditions incoming power so that all-too-common sags and surges don't damage sensitive electronic gear.

What are the main types of UPS?

UPSs come in three major varieties, which are also known as topologies:

Single-conversion systems

In normal operation, these feed incoming utility AC power to IT equipment. If the AC input supply falls out of predefined limits, the UPS utilizes its inverter to draw current from the battery, and also disconnects the AC input supply to prevent backfeed from the inverter to the utility. The UPS stays on battery power until the AC input returns to normal tolerances or the battery runs out of power, whichever happens first. Two of the most popular single-conversion designs are standby and line-interactive:

- Standby UPSs allow IT equipment to run off utility power until the UPS detects a problem, at which point it switches to battery power. Some standby UPS designs incorporate transformers or other devices to provide limited power conditioning as well.
- Line-interactive UPSs regulate input utility voltage up or down as necessary before allowing it to pass through to protected equipment. However, like standby UPSs, they use their battery to guard against frequency abnormalities.

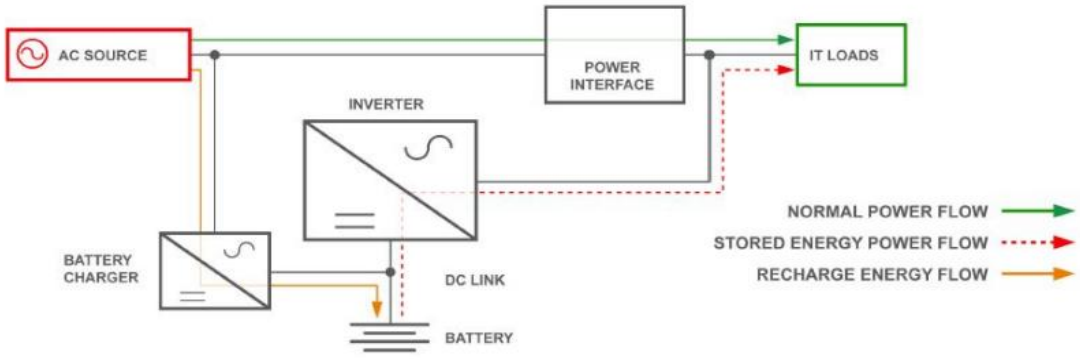


Fig 1.32 Internal design of a line-interactive UPS.

Double-conversion systems

As the name suggests, these devices convert power twice. First, an input rectifier converts AC power into DC and feeds it to an output inverter. The output inverter then processes the power back to AC before sending it on to IT equipment. This double-conversion process isolates critical loads from raw utility power completely, ensuring that IT equipment receives only clean, reliable electricity.

In normal operation, a double-conversion UPS continually processes power twice. If the AC input supply falls out of predefined limits, however, the input rectifier shuts off and the output inverter begins drawing power from the battery instead. The UPS continues to utilize battery power until the AC input returns to normal tolerances or the battery runs out of power, whichever occurs sooner. In case of a severe overload of the inverter, or a failure of the rectifier or inverter, the static switch bypass path is turned on quickly, to support the output loads.

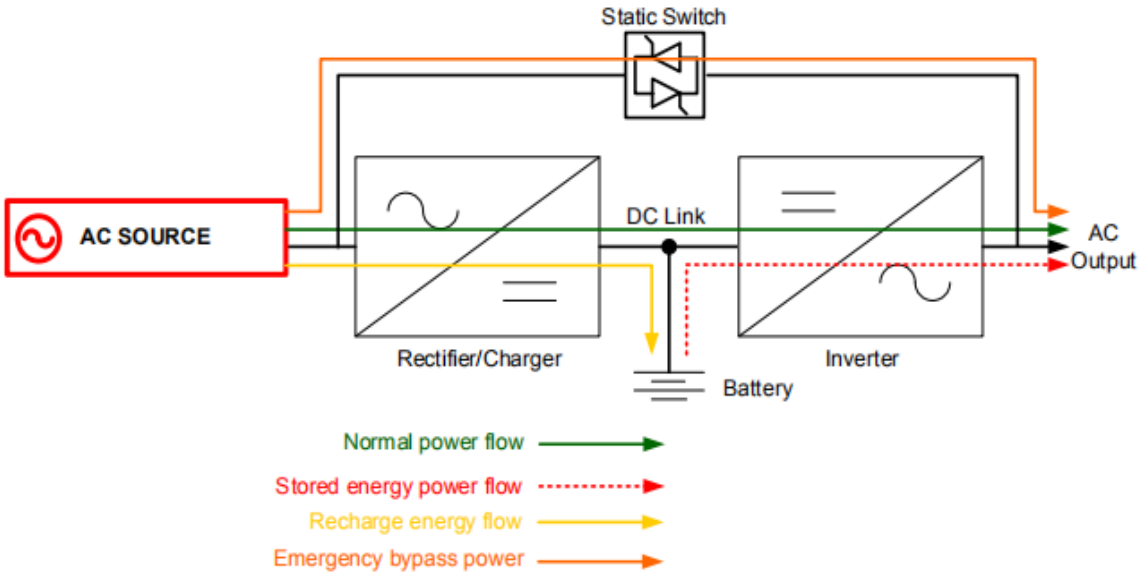


Figure 1. 33 Internal design of a double-conversion UPS.

Multi-mode systems

These combine features of both single- and double-conversion technologies while providing substantial improvements in both efficiency and reliability:

- Under normal conditions, the system operates in line-interactive mode, saving energy and money while also keeping voltage within safe tolerances and resolving common anomalies found in utility power.
- If AC input power falls outside of preset tolerances for line-interactive mode, the system automatically switches to double-conversion mode, completely isolating IT equipment from the incoming AC source.

- If AC input power falls outside the tolerances of the double-conversion rectifier, or goes out altogether, the UPS uses the battery to keep supported loads up and running. When the generator comes online, the UPS switches to double-conversion mode until input power stabilizes. Then it transitions back to high-efficiency line-interactive mode.

Multi-mode UPSs are designed to dynamically strike an ideal balance between efficiency and protection. Under normal conditions, they provide maximum efficiency. When problems occur, however, they automatically sacrifice some efficiency to deliver maximum levels of protection. The end result is that data centers can save tens of thousands a year on energy without compromising data center performance or reliability.

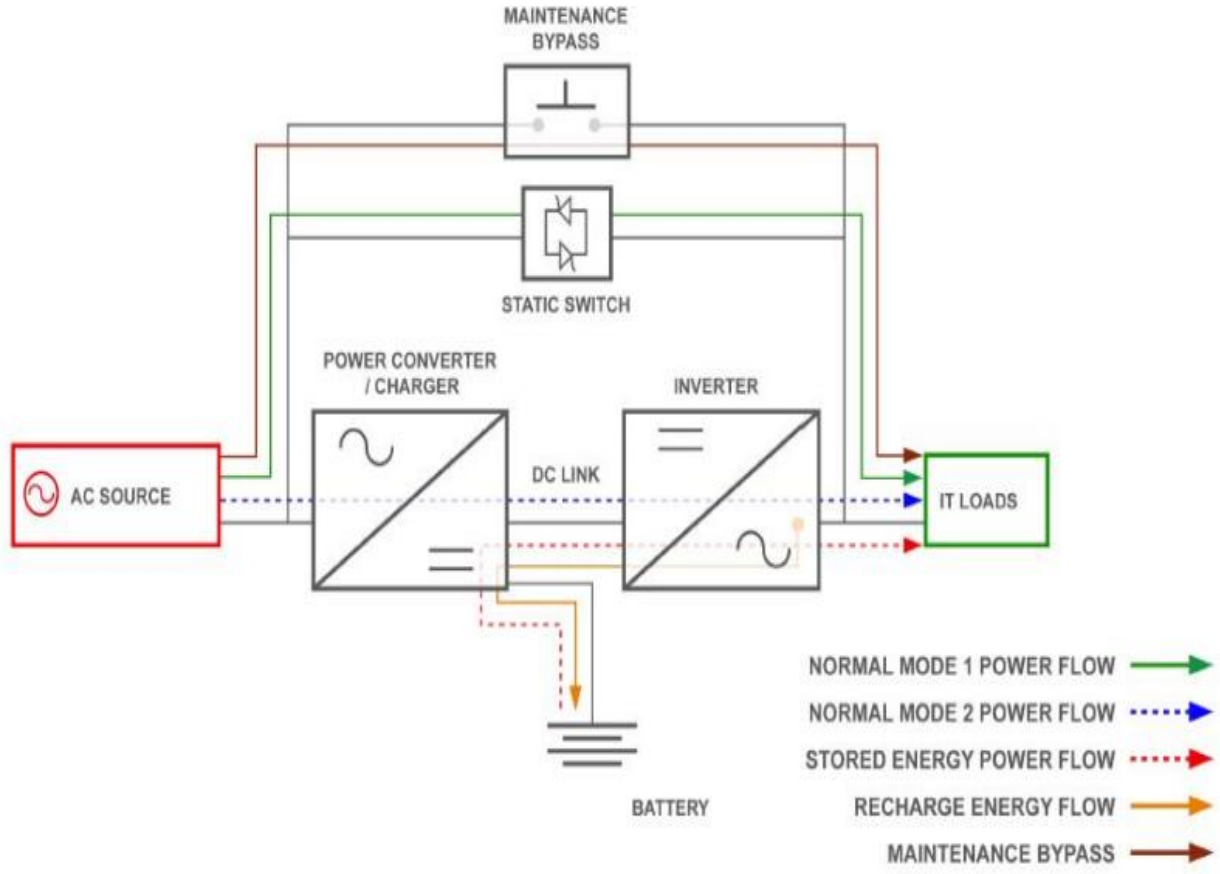


Figure 1.34 Internal design of a multi-mode UPS.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. _____ Using your hands is an almost indispensable part of any job and thus there is always the risk of getting your hands injured.(1 points)

   A) Eye Protectors C. protective Glove
   B) Safety Footwear D. dust mask

2. Safety hazards associated with maintenance activities in a chemical agents(1points)

   A) Cleaning solvents C. Noise
   B) Vibration D. Thermal

3. List types of equipment maintenance (3 points)

   a) _____
   b) _____
   c) _____

4. list 4 image formation system of photocopy machine process(4points)

   a)_____
   b)_____
   c)_____
   d)_____

Note: **Satisfactory rating - 5 and 9 points Unsatisfactory -4 below 5 and 9points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating:

Name: _____ Date: _____

Short Answer Questions

Information Sheet- 2	Verifying preventive maintenance history in line with the company procedures

2.1Verifying preventive maintenance history in line with the company procedures

2.1.1 Procedures, records and histories

Definition of Maintenance Procedures

Maintenance procedures are written instructions that, when followed by the maintenance personnel, will ensure that equipment operates as designed within safe operating limits.

The above definition follows the same approach as that used for operating procedures. Equipment and facilities must operate in the safe range. Preventive maintenance helps ensure that equipment stays in that range; repair maintenance restores equipment to its normal function.

Many of the techniques described in the previous section can be useful in the preparation of maintenance procedures—however, maintenance tasks are not usually so concerned with a long sequence of activities, and they tend to benefit more from the use of equipment sketches and pictures than do operating procedures.

Maintenance procedures and other work-related documents should identify preconditions and precautions, provide clear instructions for work to be done, and be used to ensure that maintenance is performed in accordance with the maintenance strategy, policies and programmers

Priority should be given to amending and updating procedures in a timely manner. A mechanism should be implemented which enables users to feedback suggestions for the improvement of procedures.

Maintenance History should be used to support maintenance activities, upgrade maintenance programmers, optimize equipment performance and improve equipment reliability. Appropriate arrangements should be made for orderly collection and analysis of records and production of reports on maintenance activities. Maintenance history records should be easily retrievable for reference or analysis.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. _____ should be used to support maintenance activities, upgrade programmers, optimize equipment performance and improve equipment reliability.(2 point)

   B. data-sheet C. Maintenance History

   C. policies D. Services

2. _____ Procedures are written instructions that, when followed by the maintenance personnel, will ensure that equipment operates as designed within safe operating limits. (2 point)

   A. Data-sheet C. Maintenance History

   B. policies D. Maintenance procedures

Note: **Satisfactory rating – 2.5 and 4 points Unsatisfactory below 2 and 4 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-3	Finding ***Service manuals*** and ***service information*** required for preventive maintenance as per standard procedures.

3.1 Finding *Service manuals* and ***service information*** required for preventive maintenance

3.1.1 Service manuals

Service manual/schematic diagram/parts list

Factory service manuals (FSM) are the manuals provided by manufacturers which cover the servicing, maintenance and repair of their products. They were not originally offered to the public as they were developed for the dealerships so that their mechanics were able to fix their own products.

A **schematic diagram** is a picture that represents the components of a process, device, or other object using abstract, often standardized symbols and lines. Although schematic diagrams are commonly associated with electrical and electronics circuits. For example, in a schematic diagram representing an electrical circuit, you can see how the wires and components are connected together, but not photographs of the circuit itself.

Component data sheet/handbook

A **data-sheet** or **spec-sheet** is a document that summarizes the performance and other characteristics of a product, machine, component (e.g., an electronic component), material, a subsystem (e.g., a power supply) or software in sufficient detail that allows a buyer to understand what the product and a design engineer to understand the role of the component in the overall system. Typically, a datasheet is created by the manufacturer and begins with an introductory page describing the rest of the document, followed by listings of specific characteristics, with further information on the connectivity of the devices. In cases where there is relevant source code to include, it is usually attached near the end of the document or separated into another file. Data-sheets are created, stored and distributed via Product information management or Product data management systems.

Depending on the specific purpose, a datasheet may offer an average value, a typical value, a typical range, engineering tolerances, or a nominal value. The type and source of data are usually stated on the datasheet.

A datasheet is usually used for the commercial or technical communication to describe the characteristics of an item or product. It can be published by the manufacturer to help people choose products or to help use the products. By contrast, a technical specification is an explicit set of requirements to be satisfied by a material, product, or service.

Product data-sheet information

A product data-sheet (PDS), like any data-sheet, has a different data model per category. It typically contains:

- Identifiers like manufacturer & manufacturer product code

- Classification data,
- Descriptions such as marketing texts
- Specifications
- Product images
- Feature logos
- Reasons-to-buy
- Leaflets, typically as PDFs
- Manuals, typically in PDF.
- Product videos, 3D objects, and other rich media assets.

Service information

Job Orders

Definition: Job order is a documented task specifications that an individual is required to complete the task at a given unit of time.

Job orders are very much and highly recommended for each and every skilled worker in his/her work environment particularly in almost all industries. In which, most of these industries required it for the purpose of written report or a documented report of the task being perform.

There are several kinds of job orders as well as formats and required information that may vary depending upon the nature of the industry or a service canter.

JOB ORDER CONTENTS

Job Order control Number is basically non-identical number usually located at the upper left or right corner of the sheet usually written in different colour.

Name of Client This field contains the clients name usually divided in three (3) parts, the family name, first/given name and the middle initial. But some job orders may only have one (1) single field that requires the complete name of the client.

Contact Number requires the client contact number either a cellular phone number or a landline telephone

Client's Address requires the current address of the client

Job Description represents the overall overview of the task to be perform

Date and Time The date when the job order is requested of delivered

Date Finished The date when the task is completed.

Signature Signatures are areas of the job order form that requires the signature of the technician and the client that serves as the specimen of agreement between the two parties.

JOB ORDER

Job Order No:			**Date:**	
Name of Client:	*(Family Name):*	*(Given Name):*	*MI:*	Contact No:
Client's Address:				
Appliance Type:	*Brand name:*	*Model:*	Serial:	*Color:*

Appliance Physical Pre-Conditions: 1. _____ 2. _____ 3. _____		*Symptoms:* 1. _____ 2. _____ 3. _____
Date & Time Received: Date_____/Time_____	Expected Date & Time to be released: Date_____/Time_____	*Received by:*
Assigned Technician: _____	*Date Received:*	*Technician's Pre-Condition Findings:* 1. _____ 2. _____
Diagnose Results: 1. _____ 2. _____ 3. _____		
Replacements: (*If any)*		

No. of Items	Description	Price/Unit	Total/Unit	Remarks
		TOTAL AMOUNT:		

Report: _____ _____	*Signature of Technician:*
Total Billing: (Amount in words)	(w/ Service Charge)

Date & Time Released: Date_____/Time_____	*Released by:*	*Received by: (Owner)*

Figure 3.1 *Sample Job Order*

Preparing Job Orders

For most service centres, preparation of job before the start of every task is required. Basically, preparing job orders are just filling out the information required. In addition, a short conversation should take place between the owner and the one who prepares the job order.

Most of the questions that should be ask:

1. When was this equipment started to show irregular operation or malfunctioning.
2. Events took place before the fault happened
3. Repair history of the equipment if any.

These questions are most likely to be ask, since this information could lead some conclusions and future awareness.

Interpreting Job Orders

For most of the industry they provide job orders to their skilled workers to have a concrete formal request of the task to be done. Before each task to be done the worker should be able to secure the job order, "**no job order means NO task to be done**". Upon receiving the job order make sure that all required fields are correctly and clearly written.

First, check date and Job Order control number for its validity. Next, is to check the client's name, address and contact number, this information is highly required, which means that if this required information are missing, the worker should refer to the immediate supervisor.

The most important part of the job order is the task description in which each worker should be able to understand and be able to attain the task requirement within the specific period of time which is also can be seen under the date and time of completion.

As a worker, time consciousness is very important to be able to attain the required span of time.

Self-Check -3	Written Test

Part I: Define the following terms

Directions: Match the terms with the following statements found on the right side. Write the corresponding letter Job Order Control Number

_____1. Job Order Control Number

_____2. Name of Client

_____3. Contact Number

_____4. Client's Address

_____5. Job Description

_____6. Date and Time

_____7. Date Finished

_____8. Signature

Column B

a. The date when the task is completed.

b. This field contains the clients name usually divided in three (3) parts, the family name, first/given name and the middle initial. But some job orders may only have one(1) single field that requires the complete name of the client.

c. is basically non-identical number usually located at the upper left or right corner of the sheet usually written in different color.

d. requires the current address of the client

e. represents the overall overview of the task to be perform

f. requires the client contact number either a cellular phone number or a landline telephone

g. Signatures are areas of the job order form that requires the signature of the technician and the client that serves as the specimen of agreement between the two parties.

h. The date when the job order is requested of delivered

Part II: Matching Item

Directions: Answer all the questions below. Illustrations may be necessary to aid some explanations/answers

1. What is a job order?
2. What should be the first thing to check before performing the task specifications?
3. Why it is that time consciousness is important when performing the task?
4. What is the main principle of a worker when dealing with task/job orders?
5. Why it is that job order number and the date should be check first when receiving the job order?

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating:

Part I

Answers:

1. _____
   _____
   _____.
2. _____
   _____
   _____.
3. _____
   _____
   _____.
4. _____
   _____
   _____.
5. _____
   _____
   _____.

Name: _____ Date: _____

Short Answer Questions

Information Sheet-4	Setting or arranging workplace for repair job in accordance with company standard procedures

4.1 **Setting or arranging workplace for repair job**

PLAN AND PREPARE WORK SPECIFICATION

After the job order is clearly understood, the worker should immediately perform task planning and preparation based on the job specifications.

Steps:

1. Prepare workstation as required based from the job specifications. Make sure that 5's is implemented as well as safety precautions.
2. Make the workplace free of un-necessary objects.
3. Prepare the tools and devices that are only needed.
4. The following tools and devices needed for the following jobs:

A) Pre-testing:

- ✓ Multi-tester
- ✓ Personal Protective Equipment
- ✓ Service Manual/Owner's Operating Manual

B) Dis-assembling/Assembling:

- ✓ Screw Drivers
- ✓ Pliers
- ✓ Tweezers
- ✓ Cleaning Brush
- ✓ Wrenches
- ✓ Soldering Iron with stand
- ✓ De-soldering pump
- ✓ Allen wrench Service Manual

C) Diagnostic/Fault Finding Procedures:

- ✓ Multi-tester
- ✓ Soldering Iron with stand
- ✓ De-soldering pump
- ✓ Soldering lead
- ✓ Oscilloscope
- ✓ ESD-free workbench with mirror
- ✓ Service Manual

Note: It may also require special devices and tools depending on the equipment's need.

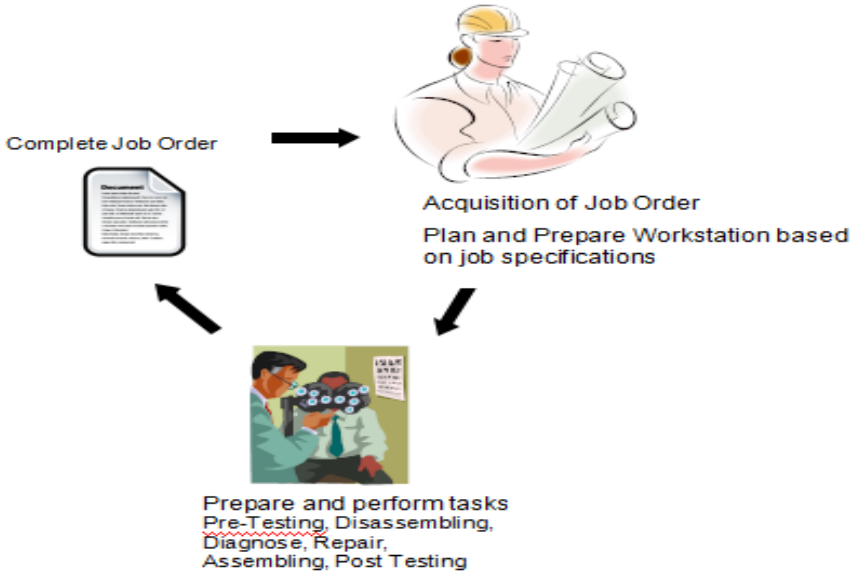
D) Repair Procedures:

- ✓ Soldering Iron with stand
- ✓ De-soldering pump
- ✓ Soldering Lead
- ✓ Soldering paste
- ✓ Thinner
- ✓ Cleaning brush
- ✓ Multi-tester
- ✓ Oscilloscope
- ✓ Stripper/Knife
- ✓ Electronic components for replacement

✓ Service Manual

REPORTING

Upon completion of the task, the worker should be able to complete the information found in the job order. Make sure that each and every job is completed; a final report should be submitted to the immediate superior.



Self-Check -4	Written Test

Part I: Multiple choices

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. _____ is completion of the task, the worker should be able to complete the information found in the job order. (3 points)

A. Job order C. Report

B. Job specification D. Gathering information

Part II: Define the following terms

1. During the pre-testing procedure, what are the tools and devices needed to be able to perform the task?

_____
_____
_____.

2. During the diagnostic/fault finding procedure, what are the tools and devices needed to be able to perform the task?

_____
_____
_____.

3. Is Soldering Iron needed for pre-testing procedures?

☐ Yes

☐ No

☐ Maybe

Note: **Satisfactory rating –3 and 4 points** **Unsatisfactory - below 3 and 4 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Instruction Sheet	LG43: Perform preventive maintenance

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

2.1. Inspecting carefully external part of the equipment visually
2.2. Opening equipment case according to manual
2.3. Freeing from dust internal part of the equipment using blower
2.4. Tightening or re-soldering loose connection correctly and firmly with cold solder if appropriate
2.5. Lubricating moving parts in accordance with manufacturer's specifications using appropriate materials and tools
2.6. Cleaning mechanical parts using appropriate cleaning materials

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Inspect external part of the equipment visually and open carefully Equipment case according to manual
- Free internal part of the equipment from dust using blower
- Tight or re-solder loose connection firmly correctly and firmly with cold solder if appropriate
- Lubricate moving parts in accordance with manufacturer's specifications using appropriate materials and tools
- Clean mechanical parts using appropriate cleaning materials

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information "Sheet 1, Sheet 2, Sheet 3, Sheet 4, Sheet 5 and Sheet 6".
4. Accomplish the "Self-check 1, Self-check t 2, Self-check 3 and Self-check 4" **in page - 64, 66, 71, 75, 80 and 94** respectively.
5. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet 1" **in page -95.**
6. Do the "LAP test" **in page – 96** (if you are ready).

Information Sheet 1	Inspecting carefully external part of the equipment visually

Visual Inspection

The installation must be visually inspected before testing begins. The aim of the visual inspection is to confirm that all equipment and accessories are undamaged and comply with the relevant British and European Standards, and also that the installation has been securely and correctly erected Regulation 611.3 gives a checklist for the initial visual inspection of an installation, including:

- Connection of conductors;
- Identification of conductors;
- Routing of cables in safe zones;
- Selection of conductors for current carrying capacity and volt drop;
- Connection of single-pole devices for protection or switching in phase conductors only;
- Correct connection of socket outlets, lamp holders, accessories and equipment;
- Presence of fire barriers, suitable seals and protection against thermal effects;
- Methods of 'basic protection' against electric shock, including the insulation of live parts and placement of live parts out of reach by fitting appropriate barriers and enclosures;
- Methods of 'fault protection' against electric shock including the presence of earthing conductors for both protective bonding and supplementary bonding.
- Prevention of detrimental influences (e.g. Corrosion);
- Presence of appropriate devices for isolation and switching;
- Presence of under voltage protection devices;
- Choice and setting of protective devices;
- Labelling of circuits, fuses, switches and terminals;
- Selection of equipment and protective measures appropriate to external influences;
- Adequate access to switchgear and equipment;
- Presence of danger notices and other warning notices;
- Presence of diagrams, instructions and similar information;
- Appropriate erection method.

Inspection Requirements

Verify that selected elements associated with the applicant's program for inspection, test control, (as identified in an approved inspection plan) is in accordance with the applicant's approved QA Plan.

Elements chosen for inspection may include three or more of the following:

Verify that inspection requirements and acceptance criteria are contained in the applicable design documents approved by the responsible design organization. Verify that inspection activities are documented and controlled by instructions, procedures, drawings, checklists, travelers, or other appropriate means.

- Verify that tests required verifying conformance of an item to specified requirements, and to demonstrate satisfactory performance for service, are planned and executed. Verify that the characteristics to be tested and test methods to be employed are specified. Verify that test results are documented and their conformance with acceptance criteria is evaluated.
- Verify that the applicant has established controls for tools, instruments, gauges, and other used for quality-affecting activities. Verify that is controlled, calibrated (at specified periods), and adjusted to maintain accuracy within necessary limits.
- Verify that the applicant has established the requirements to identify the status of inspection and test activities. Verify that the status is indicated either on the items or in documents traceable to the items, where it is necessary to assure that required inspections and tests are performed, and to assure that items that have not passed the required inspections and tests are not inadvertently installed, used, or operated. Verify that the status is maintained through indicators (i.e., physical location and tags, markings, shop travelers, stamps, inspection records, computerized logs, or other suitable means). Verify that authority for application and removal of tags, markings, labels, and stamps is specified. Verify that status indicators provide for indicating the operating status of systems and components of the facility (i.e., tagging valves and switches) to prevent inadvertent operation.

Inspection Guidance

The inspector should refer to the applicant's approved QA Plan for specific requirements and commitments. Verify that the following inspection activities are documented and controlled by instructions, procedures, drawings, checklists, travelers, or other appropriate means:

A) Inspection Planning.

Verify that documented inspection planning includes the following:

1. Identification of each work operation where inspection is necessary to ensure quality;
2. Identification of documents that are used to perform the inspections;
3. Identification of the characteristics for inspection and the identification of when, during the work process, inspections are to be performed for those characteristics;
4. Identification of inspection or process-monitoring methods employed;
5. Sufficient information from the final inspection, to provide a conclusion regarding conformance of the item to specified requirements;
6. Identification of the functional-qualification level (category or class) of personnel performing inspections;
7. Identification of acceptance criteria;
8. Identification of sampling requirements;
9. Methods to record inspection results; and Selection and identification of the maintenance to be used to perform the inspection to ensure that the equipment is calibrated and is of the proper type, range, accuracy, and tolerance to accomplish the intended function.

B) Selecting Inspection persons to Perform Inspections.

1. Determine that the individual who performs an inspection to verify conformance of an item to specified acceptance criteria is qualified to the requirements specified in the applicant's approved QA Plan.
2. Verify that inspections are performed by personnel other than those who performed or directly supervised the work being inspected. Verify that inspection personnel do not report directly to the immediate supervisor responsible for the work being inspected.

C) Inspection Hold Points.

1. If mandatory inspection hold points are used to control work, then verify that specific hold points are indicated in documents.
2. When applicable, verify that consent to waive hold points are documented and approved before to continuing work beyond the designated hold point.

D) In-Process Inspections and Monitoring.

1. If inspection of processed items is not practicable, then verify that indirect control is provided by the monitoring of processing methods, equipment, and personnel.
2. Verify that both inspection and process monitoring are conducted, when control is inadequate with only one method.
3. Verify that controls are established and documented for the coordination and sequencing of the work at established inspection points during successive stages of the process.

E) Final Inspection.

1. Verify that finished items are inspected for completeness, markings, calibration, adjustments, protection from damage, or other characteristics, as required to verify the quality and conformance of the item to specified requirements.
2. Verify that final inspections include a review of the results and resolution of nonconformance's identified by earlier inspections. If modifications, repairs, or replacements of items are performed subsequent to the final inspection, then verify that appropriate re-tests or re-inspections are performed.

F) Accepting Items.

Verify that the acceptance of an item is documented and approved by qualified and authorized personnel.

G) . Inspection Documentation.

Verify that inspection documentation includes the following:

1. The item inspected, date of inspection, the name of the inspector, or the inspector's unique identifier, who documented, evaluated, and determined acceptability;
2. The name of the data recorder, as applicable, and the type of observation or method of inspection;
3. The inspection criteria, sampling plan, or reference documents used to determine acceptance;
4. Results indicating acceptability of characteristics inspected;
5. during inspection, including the identification number and the most recent calibration date; and
6. Reference to information on actions taken in connection with nonconformance.

Equipment Inspection Test Procedure

Purpose: This operation enumerates the proper procedure of faulty equipment pre-testing

Equipment, Tools and Materials:

- Job Order Form
- Pencil/Ballpen
- Faulty equipment
- Appropriate Tools and devices

Conditions or Situations for the Operation:

- Consider that the event took place in an appliance service center.
- The Trainee is the service technician

Procedure:

<u>Equipment Inspection Test Procedure</u>

- Upon receiving the preventive maintenance/defective equipment from the owner:
  - Start having an informal conversation and gather information (a sort of investigation) asking some important questions that may lead to some hypothesis of the current fault.
  - Inspect physical damages such as cracks, missing screws, etc.
  - Test the main power cord of the equipment for possible short circuits using a multi-tester
  - If no short circuit found, proceed on powering the equipment. Observe
  - At the same time make sure it is documented
  - After all the checkups are done. Schedule an appointment with the owner and inform the actual condition of the appliance.

Precautions:

- Apply Kaizen/5's
- Safety

Quality Criteria:

- The trainee should be able to perform the following procedures accordingly

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1._____is the first method used for preventive maintenance. (2 points)

A) Production planners C) Local resources

B) Visual inspection D) Assessments

2._____From the given alternative not Inspection Guidance (2 points)

A) Inspection Documentation C) Inspection Hold Points

B) Final Inspection D) Collect data

2 List of Inspection Guidance (5 points)

a) _____

b) _____

c) _____

d) _____

e) _____

f) _____

Note: **Satisfactory 4rating - 8 points** **Unsatisfactory -4 below 8 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet 2	Opening equipment case according to manual

2.1 Opening equipment case according to manual:

Documenting a Preventative Maintenance Program

Make sure that all maintenance activities are well documented. Keep records of staff training, regular repairs, purchases, pre-operation inspection findings, etc. Documents should show that the preventative maintenance program supports all other prerequisite programs. The preventative maintenance program will include:

- A facility's material for inspection equipment and maintenance requirements;
- Maintenance equipment and what is needed to maintain them; and
- Regular inspection or maintenance activities, procedures and frequencies.

Staff training ensures that employees have the skills they need for effective preventative maintenance.

Equipment Records

Necessary equipment records include:

- All manufacturers' literature such as manuals, drawing sand lists of spare parts;
- Flow diagrams of the entire facility;
- Individual diagrams showing locations of all equipment and production processes; and
- A recording and reporting system of performance inspection sand activities for each piece of equipment.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Necessary equipment records include (3 points)
   A. A facility's material for inspection
   B. Regular inspection or maintenance activities
   C. Maintenance equipment & what is needed
   D. Final Inspection
2. List preventative maintenance program will include (3 points)
   a) _____
   b) _____
   c) _____

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

information Sheet 3	Freeing from dust internal part of the equipment using blower

3.1 Free from dust internal part of the equipment using blower

3.1.1 Cleaning Methods for Electrical/Electronic Preventive Maintenance

Electrical equipment should be kept clean for maximum efficiency and service longevity. Keeping electrical equipment clean is an important part of any electrical preventive maintenance program, but using the wrong cleaning methods could be costly.

Initial Considerations

Determine the cleaning method by observing the type of contamination to be removed and the time allowed until the equipment needs to be returned to service**.** Sufficient dry time is required when using liquid solvents or water to clean electrical equipment. Insulation should be tested to determine whether it has been properly reconditioned before re-energizing equipment.

Methods of Cleaning Electrical/Electrical Apparatus

DANGER: Never attempt to clean electrical power equipment while it's energized. Remember to observe all safe work practices and lockout/tag out procedures prior to cleaning. Personnel should be properly qualified before cleaning electrical equipment.

Rags and Brushes

Wiping off dirt with a clean, dry, lint-free cloth or soft brush is usually satisfactory if the apparatus is small, the surfaces to be cleaned are accessible, and only dry dirt is to be removed. Don't use waste rags when cleaning electrical equipment because lint will adhere to the insulation, acting as a further dirt-collecting agent, which can cause tracking. Cloth rags should be clean and free of oil, grease, and metallic deposits.

Use care to avoid damage to delicate parts. Rags can easily catch on edges other and sharp objects, which could damage small plastic or moving parts.

1. Liquid Solvents and Water

Accumulated dirt, oil, or grease might require a solvent to be removed. A rag barely moistened (not wet) with a nonflammable solvent can be used for wiping. Solvents used for cleaning of electrical equipment should be selected carefully to ensure compatibility with materials being cleaned. Accumulated dirt, oil or grease might require liquid solvents or other alternative methods to be removed.

Do not use any liquid cleaners, including spray cleaners, unless specified by the equipment manufacturer, because of the risk of residues causing damage, interfering with electrical or mechanical functions, or compromising the integrity of insulation surfaces.

NOTE: Allow sufficient time for drying after cleaning equipment with a liquid solvent or water!

Observe all material data sheets prior to using chemical cleaners. Wear the required **personal protective equipment (PPE)** such as goggles, gloves, aprons, and respirators when working with potentially hazardous solvents.

2. Vacuum Cleaning

Loose dust, dirt, and particles can be removed using a vacuum-type cleaner with non-metallic attachments and hoses. Blowing equipment out with compressed air is likely to spread contamination and damage insulation.

Equipment enclosures and substation room filters should be cleaned at regular intervals and replaced if they are damaged or blocked. Loose hardware and fragments should be removed from the enclosures. New or unusual wear or loss of parts occurring after the cleaning can be detected during subsequent maintenance.

3. Sweeping and Moping

If the sweeping of a substation room is required, use a comprehensive compound to limit the amount of dirt and dust becoming flying. When mopping, keep the mop bucket as far as practical from the switchgear to prevent damage from spillage.

Compressed Air Methods for Cleaning Electrical Equipment

Where dirt cannot be removed by wiping or vacuuming, compressed air blowing might be necessary.

CAUTION: Cleaning with compressed air can create a **hazard to personnel** and cause **equipment to fail** or malfunction. If compressed air is used, *protection should be provided against injury to workers' faces and eyes* from flying debris and to their lungs from dust inhalation.

Use care when working with compressed air to avoid contaminants from become airborne, which can contaminate insulation surfaces, cause injury to personnel, or affect the mechanical operation of nearby equipment. Compressed air should be dry and directed in a manner to avoid further blockage of ventilation ducts and recesses in insulations.

Protection might also be needed against contamination of other nearby equipment if the insulation is cleaned in place with compressed air. Removed the apparatus to a suitable location for cleaning, or other exposed equipment should be covered before cleaning starts to keep the debris out.

Sandblasting and Shot Blasting

Electrical equipment might require cleaning by nonconductive sandblasting. Shot blasting should not be used.

Asbestos Exposure

Asbestos is a **toxic substance** subject to government regulations. **Special considerations should be taken when cleaning aged equipment that may contain asbestos,***especially when using compressed air methods.*

Cleaning the internal part of the equipment and its components

Cleaning internal part of components help keep everything in good working condition, helps prevent insects from spreading, and helps allow proper air flow. The fig 3.1 shows a good example of how dirty the inside of your computer case can get. Looking at this picture it's immediately obvious that all the dust and dirt is going to prevent proper air flow and may even prevent the fan from working.

Fig 3.1 dust inside computer

Cleaning tools

Although computer cleaning products are available, you can also use household items to clean your computer and its peripherals. Below is a listing of items you may need or want to use while cleaning your computer.

- **Cloth** - A cotton cloth is the best tool used when rubbing down computer components. Paper towels can be used with most hardware, but we always recommend using a cloth whenever possible. However, only use a cloth when cleaning components such as the case, a drive, mouse, and keyboard. You should not use a cloth to clean any circuitry such as the RAMor motherboard.
- **Water or rubbing alcohol** - When moistening a cloth, it is best to use water or rubbing alcohol. Other solvents may be bad for the plastics used with your computer.
- **Portable Vacuum** - Sucking the dust, dirt, hairand other particles out of a computer can be one of the best methods of cleaning a computer. However, do not use a vacuum that plugs into the wall since it creates lots of static electricity that can damage your computer.
- **Cotton swabs** - Cotton swaps moistened with rubbing alcohol or water are excellent tools for wiping hard to reach areas in your keyboard, mouse, and other locations.

- **Foam swabs** - Whenever possible, it is better to use lint-free swabs such as foam swabs.

Using Compressed Air Dusters to clean Electronic Circuit Boards

As anyone who has ever looked inside electronics devices knows, they collect dust and fuzz like nobody's business. Technicians can tell you that first, electronics in use in virtually any environment from the home to the office are constantly exposed to dust (and, in the home environment, pet hair) and that secondly, the electrostatic charge that any electronics device generates attracts dust like a magnet does iron filings. It doesn't matter if the electronics device is a TV, home entertainment system component or computer, if it's been in use any length of time, it'll have dust inside.

The first thing a tech will do is use a product like Chemtronics ES1017 Duster

Fig Chemtronics ES1017 Duster

To blow out the dust. Believe it or not, clearing the dust out of a system may actually repair a problem as some dust particles can be electrical conductors, making bad circuit connections and causing issues. Also, clearing the dust and debris out of a system with compressed air enables the technician to work in a clean environment which, in the case of computers that haven't seen a lot of maintenance can be very dirty indeed.

Refer: https://www.youtube.com/watch?v=XQS9Tb8Wsdw

Refer:https://www.youtube.com/watch?v=TLjnBtnEWck

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List of items you may need or want to use while cleaning your computer.(5 point)

a)_____
b)_____
c)_____
d)_____
e)_____

Note: **Satisfactory 3rating - 5 points** **Unsatisfactory - 3below 5 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

information Sheet 4	Tightening or re-soldering loose connection correctly and firmly with cold solder if appropriate

4.1 Tightening or re-soldering loose connection

Loose Electrical Connections and Heat

Loose electrical connections cause multiple problems in appliances, heat being the most common one. We've all seen burnt wire nuts in a dishwasher power junction box or on a dryer heating element so on. But how does a loose connection produce heat?

Electrical connections need to be mechanically tight to ensure that the resistance across that connection is as low as possible, ideally 0 ohms. When a connection becomes either loose or corroded, it develops resistance. This resistance dissipates power in the form of heat when current flows through it. Even a resistance as low as 5 ohms can produce more than enough heat to burn up the connection and surrounding wires.

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Fig 4.1 heat to burn up the connection wire

Broken solder joint: an easy fix for printed circuit boards picture the situation where something works: just fine one minute, and then the next minute it doesn't. Or maybe a situation where the item in question was working fine when you put it away and then the next time you go to use it, you get nothing? Sound familiar? Then you might have a broken solder joint on a printed circuit board (or PCB for short).

Broken solder joints

A cracked, fractured or broken solder joint is sometimes (erroneously) called a 'cold' or 'dry' joint (but both those terms relate to problems with soldered joints from the start). Calling it a 'broken solder joint' and is a better description for this very common electronic failure problem.

Especially electrical items which lead a hard life; for example, devices that create lots of heat, or ones that vibrate or even stuff you plug things into (and out off) repeatedly. All this heat, movement and action weakens the delicate solder joints holding all the gibbons onto the printed circuit board (PCB's). Especially any joints that were not too good in the first place, most of our stuff is mass-produced by the lowest bidder don't forget!

A broken solder joint is where the solder connecting the component pin or leg to the copper track on the circuit boards becomes damaged. Bad contact with the copper track of course means a poor connection (intermittent problems) or no contact at all (device stops working altogether).

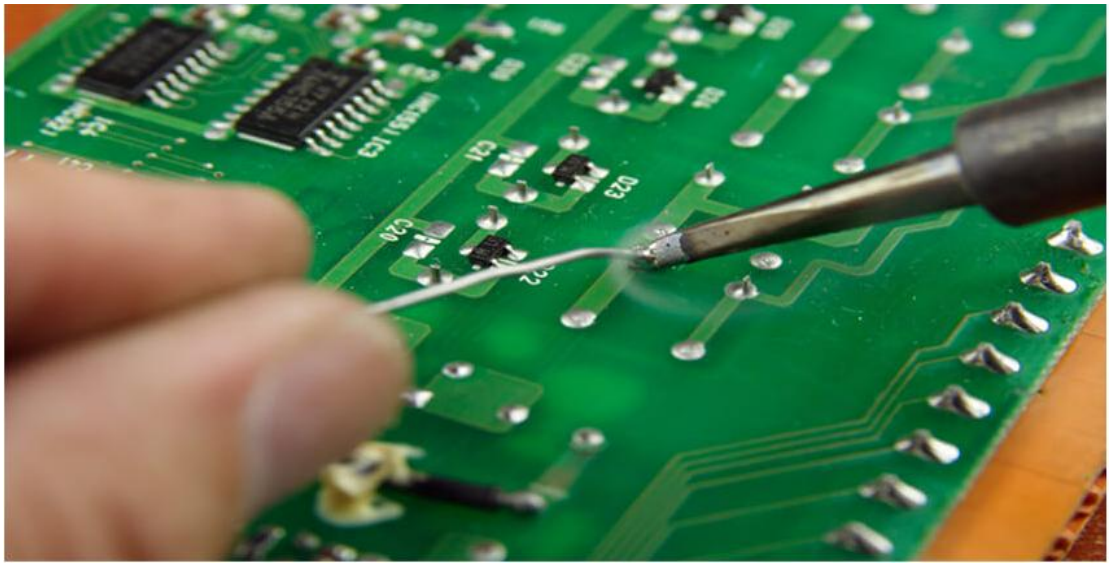


Fig 4.2 shows soldering a broken joint

Broken solder joints are often caused by…

1. Excess heat, where the pins/legs and the solder surrounding them expand and contract at different rates in use eventually causing cracking and erosion of the solder.
2. Fatigue, where the connection between the component pin/leg and the copper track cracks due to repeated movement or flexing.

3. Weakness in the joint from the start, due to poor soldering technique at the factory (too little solder or improper 'wetting' of the joint leading to poor connectivity between the component pin and the conductive track on the PCB).
4. **NB: and finally, and most importantly;** a failed component. i.e. if something is overheating to a dangerous level, it may melt the solder around the pin. In this case, the component must be replaced as re-soldering will only be a temporary fix and the overheating will either melt the solder again or could even cause a fire…

The likelihood of a soldered joint failing is increased by…

- Intermittent heating/cooling where expansion and contraction stresses connections, (power tools for example).
- Frequent and repeated moving of switches and other controls. Often the one used most creates very localized stress, (the max setting on the vacuum cleaner or cooker hood for example).
- Repeated pushing and pulling on plugs or cables physically flexes the joints between the component pins/legs and the circuit board (audio equipment for example).
- Devices that get very hot in use will eventually suffer from one too many heating/cooling cycles. Expansion and contraction stresses connections, (panel heaters for example).
- Machines that vibrate a lot because they use a big, fast motor. Vibration stresses the joints between the component pins/legs and the circuit board, (washing machines for example).
- Devices that move around a lot. Electronics don't like being thrown around too much or being knocked about as they are a bit delicate really, (laptops for example).

Fortunately fixing most of these broken solder joints is simple. The hardest part is opening up the machine to expose the PCB affected. The range of machines and electronic devices is huge so go into detail about how to expose the electronics affected, but suffice to say, you're going to need to undo any screws you can see and remove panels and/or parts that cover the PCB.

Once you can see the printed circuit board inside, go grab a magnifying glass (unless you have eyes like a peregrine falcon…) and look closely at the reverse side of the board (the side opposite the electronic wizardry). You'll see hundreds of little shiny dots with pins sticking out of them.

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Broken solder joints are often caused by…

a)_____

b)_____

c)_____

d)_____

Note: **Satisfactory rating - 4 points** **Unsatisfactory -2 below 4 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

information Sheet 5	Lubricating moving parts in accordance with manufacturer's specifications using appropriate materials and tools

3.1. Lubricating moving parts in accordance with manufacturer's specifications ;

Lubrication and Other Preventative Maintenance Activity Schedules

Preventative maintenance schedules are an important part of the equipment program. Most machines have parts that require lubrication, tightening or other adjustments.

The following is an example of a six-step process that maintenance staff can follow every day for preventative maintenance.

1. Collect the preventative maintenance schedule cards for the day (or maintenance requests from a department or staff member), or examine the maintenance schedule for required activities.
2. Collect necessary tools and lubricants.
3. Perform necessary activities and then tag machines to show the maintenance activity is complete.
4. Notify the maintenance department or production supervisor that equipment is ready to be cleaned and inspected.
5. Record the job on a card or log, and note any important issues about the maintenance or equipment.
6. Where applicable, return the cards to an appropriate location or employee

Lubrication

Lubrication is a procedure to separate the surfaces with a film of lubricant to minimize friction and to restrict wear & tear. The substances used for purpose is called "Lubrication".

PURPOSE OF LUBRICANTION

2. It minimizes the friction, wear & tear of the surfaces.
3. .It dissipates heat generated as a result of friction and acts as a coolant.
4. It prevents rusting and controls corrosion.
5. It prevents entry of moisture, dust and dirt between the moving parts and thus acting as a seal.
6. It acts as cleaning agent.
7. It acts as electric insulator in transformers, switches, gears, etc.
8. .It lengths the service-life of the components.

MODES OF LUBRICATION (OR) MECHANISM OF LUBRICATION

Following are the modes of lubrication, by which lubrication film is formed.

1. Boundary lubrication

2. Fluid film lubrication
3. Mixed lubrication.

TYPES OF LUBRICATION

On the basis of physical state the lubricants can be classified as follows.

1. Solid lubricants
2. Semi solid lubricants
3. Liquid lubricants

1. SOLID LUBRICANTS

Solid lubricant are used either in the form of dry power or mixed with water or oil so that they can stick firmly to the metal surfaces. Solid lubricants are used in special condition. When a liquid or semi-solid lubricant film cannot be maintained .When the operating temperature and pressure are too high to use liquid lubricants. Solid lubricants are used at low or high temperature also at very high loads. Examples of solid lubricants: Soap stone, graphite, talc, chalk, mica Teflon, molybdenum disulphide etc.

2. SEMI-SOLID LUBRICANTS

Greases and Vaseline are the most important semi-solid lubricants.

1. These lubricants are used for machines at slow speed and high pressure.
2. When bearing and gears to be lubricated at high temperature.
3. When sealing is required against dust, or moisture.
4. When oil-film cannot be maintained due to high load, slow speed, sudden jerks. Example: Grease, Vaseline and etc.

3. LIQUID LUBRICANTS

Since the liquid lubricants provide separation when correctly applied. They have high cooling ability when circulated through bearing area. They also act as sealing agent and prevent corrosion.

Example:

1 . Animal and vegetable oils
2 . Mineral oils
3 . Synthetic oils
4 . Blended oils

PROPERTIES OF LUBRICANTS

The following are the important properties of lubricants.

1. **Viscosity**

It is the measure of degree of fluidity of oil by which it can withstand high pressure or load without squeezing out from the bearing surface. Viscosity decreases as the temperature rise and viscosity increases as the temperature decreases. The degree of variation of viscosity with temperature is termed as viscosity index.

2. Oiliness

Oiliness refers to a combination of wet ability, surface tension and slipperiness (i.e. capacity of oil to leave an oily skin on the metal). The oiliness of lubricant oil should be high to provide efficient lubrication.

3. Flash point

It is the lowest temperature at which the vapor is given off from the oil to support a momentary flash without actually setting fire to the oil when a flame is brought within 6mm at the surface of the oil.

4. Fire point

- It is the temperature at which the oil catches fire and burns continuously. Fire point of bearing lubricants should be high in order to avoid firing of lubricant while heat dissipating.

5. **Freezing point**

- It is the temperature at which oil will cease to flow when cooled.

6**. Pour point**

- The temperature at which the lubricant is able to flow when poured.

7. Stability

- It is the ability of oil to resist oxidation. Lubricating oil should have high stability.

8. Foaming

- Foaming of a lubricant is the condition in which minute air bubbles are held in the oil. The oil should be free from foaming trouble.

9. Emulsification and de-emulsibility

- Emulsification indicates the tendency of oil to mix intimately with water to form a more or less stable emulsion.
- De-emulsibility the readiness with which subsequent separation will occur.

Lubrication Schedule

Manufactures will generally prescribe the schedule of lubrication, which should be strictly followed as a maintenance measure, will clearly specify the lubricants to be applied and the frequency. Lubricating is a regular being performed by the operators, attainders.

Lubrication chart

Printing plants should use lubrication charts, is the only way to be sure that the proper types of lubricants have been used at the proper intervals.

4.2 LUBRICATING DEVICES

Over the years, devices have been developed that through their dependability and simplicity; have become standards-in the printing industry. These lubrication devices fall into three categories: manual, semiautomatic, and automatic. The manual devices ate those to which lubricants are applied with an oilcan or grease gun. These are holes or grease fittings. With semiautomatic devices the lubricant is applied by some sort of reservoir and fed to the spot by some action on the part of the operator. A few examples are sight gravity-feed oilier, bottom-feed wick, bottle-oilier, grease cup, siphon-type oilier and pad oilier. Automatic devices, which are becoming more popular, use pressure to apply the lubricant. These system varied and complex. In addition to being designed to apply the lubricant, they are timed to give the right amount at the right time. Some systems are timed to feed oil or grease on a regular schedule.

Methods of lubrication

The moving parts are likely to wear off due to continuous rubbing action of one part with another. In order to avoid an early wearing, a proper lubrication arrangement should be provided. The following methods are used for efficient lubrication.

Gravity feed method

a. Wick feed lubrication
b. Oil cup and
c. Drip feed lubrication

Self-Check -5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. _____is the control of friction and wear by the introduction of a friction-reducing film between moving surfaces in contact. (3 points)

   A) solder joint C) Lubrication

   B) Di-solder joint D) Loose connection

2. List six-step process that maintenance staff can follow every day for preventative maintenance. (6 point)

   a) _____

   b) _____

   c) _____

   d) _____

   e) _____

   f) _____

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet 6	Cleaning mechanical parts using appropriate cleaning materials

Clean Mechanical and Electrical Part of the Equipment

Electrical equipment aging and deterioration is normal, but equipment failure is not inevitable. An effective electrical maintenance testing program identifies and recognizes factors leading to deterioration. It provides measures for reversing these effects and avoiding failures. A well administered testing program can prevent accidents, save lives, minimize costly breakdowns, and reduce unplanned outages.

Facilities are becoming progressively more dependent upon their electrical systems to maintain the continuity of processes and to transmit critical data. The continuing reliability and integrity of an electrical power system is based on an established programof maintenance and operational testing. The maintenance procedures and frequencies should follow the recommendations of nationally recognized standards.

In addition, insurance premiums can be more costly if the facility has an inadequate or marginal maintenance program.

What Maintenance Is Recommended and How Often?

The National Fire Protection Association's Recommended Practice for Electrical Equipment Maintenance (NFPA 70B) provides maintenance guidelines including suggested intervals. Another valuable resource is the Inter National Electrical Testing Association's Maintenance Testing Specifications, which has been adopted by the American National Standards Institute (ANSI/NETA MTS). These procedures and frequencies are used to develop a maintenance schedule that is based on the type of equipment, voltage, and ambient conditions. Included are transformers, circuit breakers, switches, protective relays, switchgear, panel boards, electronic and rotating equipment, bus, and cable.

There are basically three types of maintenance approaches:

1. Reactive (also known as "run-to-failure") maintenance where repair or replacement work is done only when the equipment no longer functions properly.
2. Time directed or preventive maintenance where tasks are performed on a predetermined interval, regardless of equipment condition.
3. Predictive maintenance where condition assessment tasks are performed and the equipment health is monitored or trended such that maintenance tasks can be performed when needed to avoid unacceptable deterioration or drop off in

performance. Clearly, the predictive maintenance approach is the most likely to provide system reliability and avoid failures.

How to Clean a Circuit Board

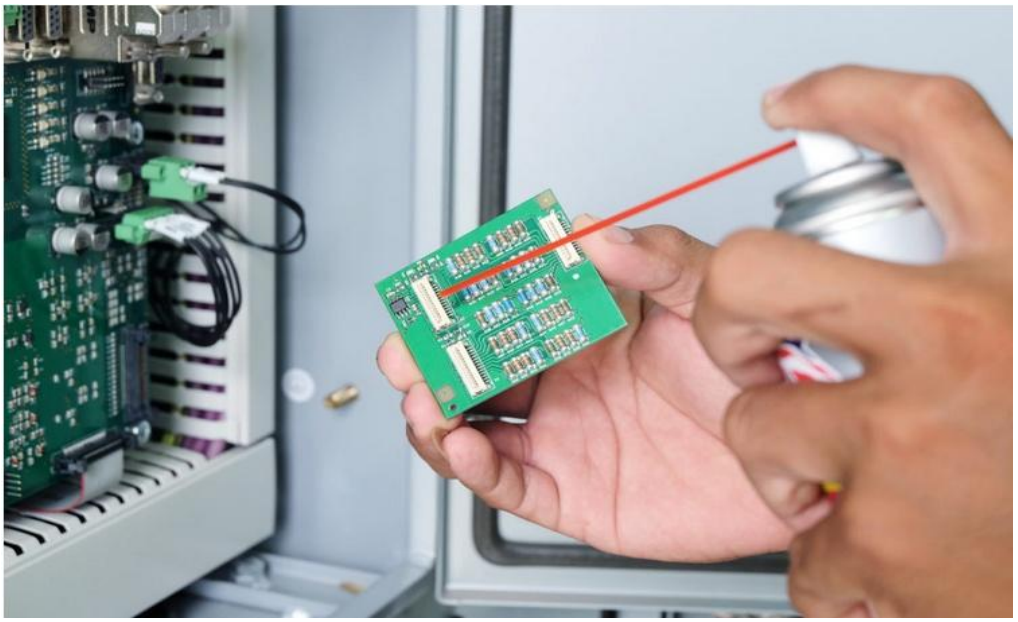


Fig 6.2 cleaning a circuit board

Cleaning a circuit board can seem like a difficult task to tackle, but these boards get dirty all the time. A slew of different materials are hazardous to the performance and safety of these devices. Watching out for such dangers and addressing the damage they cause can keep your work productive and the tools needed for the job functioning properly. Read on to learn how to clean your circuit boards while also maintaining your own safety standards.

How Do Circuit Boards Get Dirty?

Circuit boards are found in nearly all electrical devices, including computers and industrial equipment. Over time, water, dust and dirt can find their way into your company's devices and build up to a point where you must take action to prevent permanent damage to the equipment.

The fans responsible for keeping equipment's temperature at a cool environment suitable for proper functionality can draw in rubbish found in the air and any dirt clinging to nearby surfaces. The build-up of unwanted material leads to overheating and component failure.

A liquid such as water is not nearly as detrimental to electronics as the additives it almost always contains. Even plain drinking water contains ions such as sodium chloride and a slew of other minerals that heighten its reaction to electronic devices.

Once a liquid with good conductive qualities contacts an active device, electrical connections travel through currents to deactivated regions of the circuit board that can lead to short-circuiting. This harms a circuit and damages your device.

Prevention and Safety with Circuit Boards

To avoid dirty circuit boards, you can take preventative steps. Get in the habit of ensuring any electronics not in use are set to the "OFF" position, as the likelihood of adverse repercussions resulting from water damage significantly drop if the affected areas dry before reactivation.

Exercise caution when handling circuit boards:

- Disconnect the device from its power source
- Avoid standing near any water
- Wear dry clothes

Disassembling hardware can be hazardous for the electronics, so make sure you understand how to properly handle the devices you work with and how to reassemble them back to their functioning state.

How Do You Clean Circuit Boards?

Cleaning a PCB (Printed Circuit Board) effectively relies on using the right methods and tools. The easiest ways will use:

- Compressed air
- Baking soda
- Isopropyl alcohol
- Distilled water
- Household cleaners

Employ a soft brush and lint-free cloth, too, to ensure nothing gets damaged.

Using Compressed Air to Clean PCBs

For simple repairs, compressed air provides an unobtrusive way to free up any dust resting on the electronics or inside the machines and blow it out. Use short bursts to spray the air inside the ventilation ports. If you're not satisfied with the dust removed, open the device with a screwdriver and work your way around the components, carefully cleaning the circuitry with the air.

Fig 6.2 clean using compressed air

Using Baking Soda to Clean PCBs

Baking soda, or sodium bicarbonate, is an effective means of removing dust with minimal risk of damaging the board. It possesses mild abrasive qualities that excel in removing corrosion or residue that will otherwise not come off with simpler means such as a brush and distilled water. Baking soda is most effective when treating corrosion, as it dissolves the troubled area and neutralizes the acidic qualities of the residue.

Using Isopropyl Alcohol to Clean PCBs

Isopropyl alcohol is a great PCB cleaner because it is inexpensive and evaporates quickly. Compared to other cleaners used for similar purposes, alcohol contains fewer chemicals. It is important that isopropyl alcohol used to clean your circuit board is 90% or better. High-percentage isopropyl alcohol can cause adverse effects in contact with the body, so be sure to handle it with care and use latex gloves and goggles.

Using Distilled Water to Clean PCBs

Distilled water triumphs over any other form of liquid when mixing your cleaning solution due to the absence of ions conductive to electric devices. Pure distilled water will not degrade electronic devices, as it is a very poor conductor.

It also can become contaminated quickly by dirt found on your hands or in the air, so seal your reserve of distilled water when not in use and to avoid contact with your bare hands.

Using Household Cleaners to Clean PCBs

A phosphate-free household cleaner should also be in your arsenal. While phosphates can be an effective chemical to protect against corrosion and possess other helpful cleaning properties, phosphorous pollution in lakes has become a real concern for the United States since the 1970s and many manufacturers have moved away from including them in cleaning products. Since then, companies have adapted to create phosphate-free cleaners that do the job just fine.

Tools for Cleaning Printed Circuit Boards

Fig 6.3 using brush to clean PCB

Your choice of brush is also important in the cleaning process. Selecting a brush that has soft bristles and is small enough to reach small places is the best pick. A toothbrush or paintbrush are the best choices if your company does not have some sort of specialized scrubbing tool. Cutting a paintbrush diagonally is a good strategy so you can reach difficult angles with the long side while scrubbing with the short side.

Disassembling Procedure for preventive maintenance

Purpose: This operation enumerates the proper procedure of preventive maintenance equipment disassembling procedure.

Equipment, Tools and Materials:

- Faulty equipment
- Appropriate Tools and devices (see reference in learning module 1)
- Home office
  - ✓ Photocopy machine
  - ✓ Printer
  - ✓ Personal computer
  - ✓ Fax machine
  - ✓ Scanner
  - ✓ UPS

Conditions or Situations for the Operation:

- Consider that the event took place in an appliance service centre.
- The Trainee is the service technician

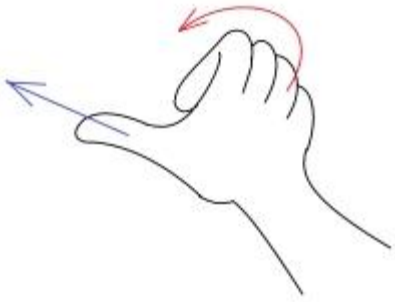
Procedure:

<u>Preventive maintenance</u>

Preventive maintenance procedure must take place upon confirmation of fault cleaning, lubrication and correct defects identified through testing and inspection procedure.

- Steps are the following:
  - Considering that all the materials and tools are already prepared and arrange according to 5S standards and PPE, start with inspecting screw positions.
  - Make sure that screws must be place in a secure place, a permanent magnet is recommended.
  - Inspect the size of the screw; remember that screw sizes may vary depending on its location and function. Use appropriate screw driver.
  - Loosing screw must be observed and done carefully so that threads will not be damage most especially when the chassis is made of plastic.
  - When loosing screws:
    a. Always remember the right hand rule.

Direction of the rotation



Direction of the screw

b. When loosing screw slowly turn screw clockwise (just apply small amount of torque).
c. Then turn counter-clock wise to lose the screw, a “tick” sound will be heard after the screw’s thread loses its grip to the chassis.
d. Make sure that the thread of the screw follows the thread of the chassis.

- Once all the screws are removed from the main chassis make sure to place them in one place.
- Remove the unscrewed cover and place it on the safe place.
- Make sure that all the body parts that are removed are placed in sequence so as not to miss any parts during the assembling procedure.
- Remove connections if necessary.

- ***Note:*** *Make sure that during the disassembling procedure always refer to the service manual. If service manual is un-available make sure that everything should be properly and orderly done.*

  For this course, electrical/electronic controlled systems will be the subject of fault finding. The Trainer will provide the equipment for the training. A separate operation manual or supplementary notes will be provided for the particular equipment.

Precautions:

- Apply Kaizen/5’s
- Safety

Quality Criteria:

- The trainee should be able to perform the following procedures accordingly

Preventive maintenance Task 1
Cleaning the internal parts of personal computer (PC)

Tools and Materials required

- A No.2 Philips cross-head screwdriver.
- A small flat-bladed screwdriver.
- One can of compressed air (more if you suspect the PC is really filthy)- from you local supermarket or electronics/computer store.
  Do NOT use compressor air - it often has a high moisture content which will cause corrosion
  and may contain aerosol lubricants which can cause electrical shorts.

- Five or six kitchen paper-towels or napkins to wipe down the case.
- One small paintbrush with long natural bristles. 1/2inch(12mm) size is ideal.
- One packet of Q-Tips or Cotton Tips.
- One Window/Glass Cleaner spray pack.
- A short length of insulating tape.
- One plain Pencil at least 4"(100mm) long.
- A pair of Scissors.
- A flashlight.
- An old Newspaper.
- A Vacuum cleaner with a hose and nozzle (if available).

Fig 6.4 different types of tools

Electrical Precautions

Inside the computer is completely safe ***with one exception*** - the power supply unit (PSU) . The PSU is in its own metal box usually at the top rear of a tower (at the rear of a desktop) and you should **NEVER** attempt to open this box or stick anything metallic into it.

The greatest danger inside the tower is of *you*"electrocuting" the computer through discharge of **static electricity** that builds up on your body or clothing. Static is especially a problem during dry weather and if you have synthetic carpets or clothing. For example a synthetic pullover (sweater) would be a bad choice of garment for this job, a short sleeved cotton shirt would be a much better choice. The best way to combat static while cleaning your computer is to wear a **static strap** attached to the chassis and worn on your wrist during the whole process.

Fig 6.5 Professional Static Strap

Setting-up

Shutdown the computer and disconnect all the cables plugged into it (you may want to mark the cables and the ports they came from with coloured stickers to help you when putting your computer back together again). You may need the flat-bladed screwdriver to undo some of the connector screws. Put newspaper down on your work surface so it doesn't get scratched. Locate your work surface near a power outlet (power point) and plug in the computer power cord (you don't need to switch it on). Put the computer on your work surface and connect the power cord to the computer but do not turn it on. Set out your tools and materials so you do not need to move around much to reach them during cleaning. Starting about two inches (50mm) from the blunt.

Opening the Case

The standard tower case usually has either a single metal cover covering the top and both sides, held in place by three or four screws or has removable side panels each held in place by two screws.

Fig 6.7 Location of Cover screws.

Use the Philips screwdriver to remove the three or four screws holding on the cover(s) and put them aside where they will not be lost. Remove the cover(s) and put them to one side but within reach. If you are using a static strap put it on your wrist and attach it to a metal part of the chasis, if you do not have a static strap touch the metal of the chasis with both hands. Then remove the power cord from the back of the computer.

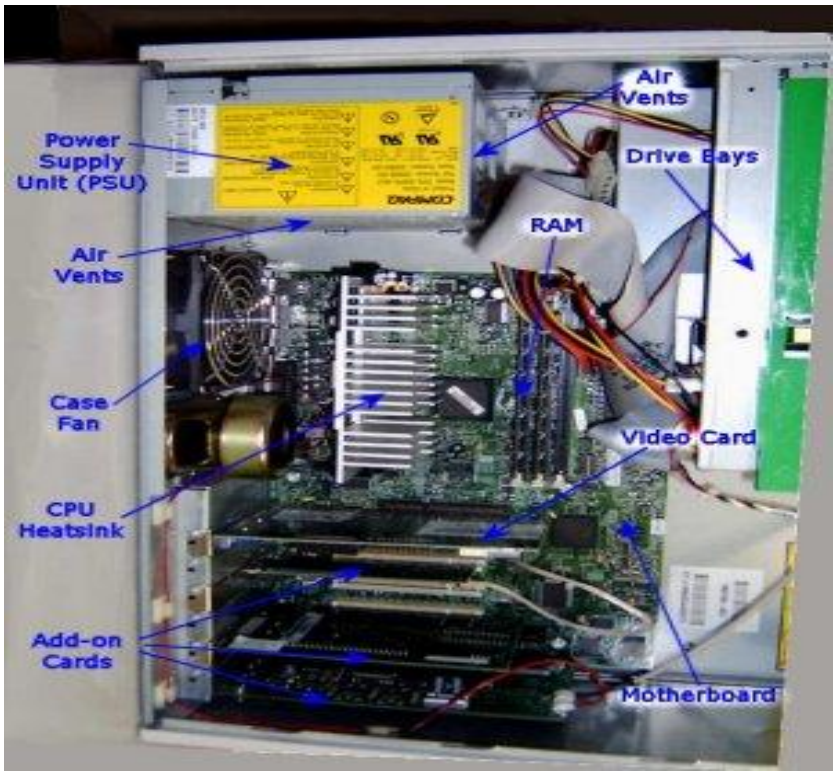


Fig 6. 8 Internal PC layouts

Fig 6.9 Preventive fan rotation

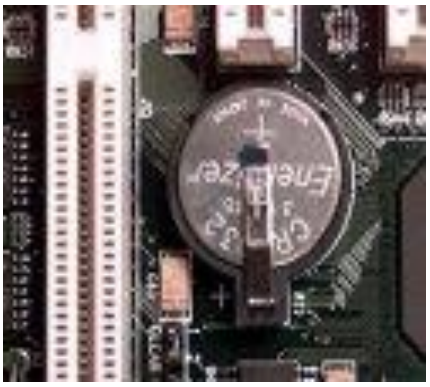
6.10 CPU fan heatsink

6.11 Cleaning RAM slot

6.12 Cleaning a case fan

6.13 Video card fan

6.14 Cleaning I/O port



6.15 CMOS battery

A. **Case vents and power supply unit (PSU) vents**

Run the vacuum cleaner nozzle over any air vents at the front, side and rear of the case and over any vents in the PSU especially the air vents in the sides of the PSU inside the computer. If the covers have vents then vacuum those as well.

B. **PSU fans**

Use the blunt, insulated end of the pencil to hold the fan blades steady and blow compressed air into the PSU fan(s) and through the PSU. Significant dust may be ejected from the power supply.

C. **CPU fan and heatsink**

This is the most important part of the cooling system - dirt collects on the fan blades and clogs the heat sink vanes. Use the paintbrush to brush the dirt off each blade and off the heat sink vanes if accessible. Using the pencil to hold the fan blades still, blow out the fan and the heat sink with the compressed air. It is important not to let the CPU fan (or other fans) spin up under the air blast as damaging voltages can be generated through a dynamo effect. Expect significant dirt to be ejected from the CPU heatsink. If you want to be particularly thorough moisten a Cotton-tip with glass cleaning fluid and wipe down the upper and lower surface of each fan blade.

D. **RAM Sticks and Expansion Slots**

Dirt can sometimes build up in 'drifts' around the memory sticks and the video, sound or modem card slots. Use the compressed air to blow it out. Do not use the brush here.

E. **Case fans**

Cases often have one or more fans attached to the front or rear panels. Using the pencil to stop fan rotation blow the dirt from the case fans with the brush and compressed air.

F. **Video card fan and heatsink**

This can be hard to see as it is usually on the lower side of the video card. Depending on the design either use the paintbrush to remove dirt from the heatsink and/or use compressed air while holding the fan still with the pencil. To do a thorough job will probably require removing the Video Card which is normally held in place with one screw where it meets the case. Remove the screw and unplug the card by pulling firmly outwards. There may be a plastic latch at the back of the card, press down on this to help eject it. If you do remove the video card keep good contact with the PC chassis as often as possible to minimize static buildup and rest the video card on part of the case while it is being cleaned. When the fan is clean use compressed air to blow out the video card slot, on older cards if the edge connectors of the card look tarnished clean them lightly with a pencil erasor. Reinsert the video card making sure the plastic latch clips into place indicating the card is properly seated in the slot (not all systems have a latch). Then do up the screw.

G. **The case**

Vacuum the dust from the bottom of the case being careful to keep the nozzle away from the motherboard. Spray some paper towels with glass cleaner and wipe down the flat metal surfaces of the case and the inside of the cover(s).

H. **The Ports**

Dust often accumulates in the I/O Ports where you plug in peripherals on the back of the computer. Use the brush and compressed air to clean them out.

I. **CMOS battery**

Although this is not a cleaning process, if your PC is more than a couple of years old this might be a good time to change the CMOS battery - usually a round, silver-coloured button battery e.g. Energiser CR2032 Lithium 3v. The battery 'pops' out of its holder with a little pressure on the side near the clip and the replacement slips in. Note: Changing the battery may reset some BIOS options to factory defaults so If you have complex BIOS settings because of SATA drives, USB keyboards, RAID controllers or network parameters for example it would be best to note down all the settings before changing the battery and check for changes afterward.

Floppy Drive, Optical Drives and Hard Drives

Fig 6.16 A Floppy Drive

Floppy drives can collect a lot of dust which could prevent them from working properly. Push the nozzle of the compressed-air can a little way into the drive opening so that the flap is held open, or use Cotton-tips to hold the flap open wide, then use the compressed air to blow out the dust. There are special floppy cleaning disks available which are used to clean the floppy drive read/write heads but these are often more expensive than replacing the drive and are only needed if the drive is old or gets very heavy usage . .

The CDROM drives or DVD drives are unlikely to be clogged by dust but they may collect dirt on the optical lens which can cause errors. Use the CD lens cleaning disk following the manufacturer's instructions to clean the lenses on these drives – this has to be done when the PC is operating. Hard Drives are sealed units and require no cleaning, but to maximise the air-flow around them use the compressed air to blow away any dust from the drive's upper surfaces.

Check the Fan Rotation

Fig 6.17 computer fan

Connect your PC power cable again and switch on the PC, while it is open, for just long enough to see that all the fans you identified above are spinning. Fans which do not spin turn into miniature heaters which make the situation worse than without a fan. If you find a fan which is not working then, after turning off the PC, note what kind of fan it is, where it is and, if possible, unplug it. You can probably order a replacement online or they may have stock in your local computer store. If the CPU fan is not working then you should not run the computer for more than a few minutes until it is replaced. If the PC has started to boot while you were inspecting the fans and is reluctant to turn off, just hold the power button in for about 5 seconds and the PC will switch off.

Reassembly

Make sure nothing has been left inside the case and nothing is likely to get caught in the fans. Any cables that were moved to get access to other items should be put back in place. Inspect the cables going to the optical drives, floppy drive and hard drive(s) to check none have been dislodged. Put the cover(s) back on the system and do up the screws to hold them in place. Unplug the power cable and return your PC to its normal location. Connect up all the cables that were originally present (following the colour code if ygu used it) and reconnect the power cable. Plug into the power outlet and switch on. Make sure your monitor is switched on and check the computer boots up.

Self-Check -6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List cleaning a PCB (Printed Circuit Board) effectively relies on using the right methods and tools.

a._____
b. _____
c._____
d._____
e._____
f. _____

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Operation Sheet-1	Cleaning mechanical parts using appropriate cleaning materials

Perform preventive maintenance of personal computer hardware parts

Step 1- Identify and prepare tools and material using for preventing maintenance

Step 2- Follow safety precaution and electrical precaution
Step 3- prepare and setting up work place and equipment for preventive maintenance
Step 4- Inspecting carefully external parts visually
Step 5- Opening equipment case
Step 6- Freeing from dust internal parts using blower
Step 7- Tightening or re-soldering loose connection
Step 8- Lubricating moving parts
Step 9- Cleaning mechanical parts
Step 10- Assemble/reassemble the equipment according to the procedure

NOTE: This operation sheet is only for one equipment but the trainer will does other equipments listed in this learning guide at LO 1.

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 1-3 hours.

Task 1: Perform preventive maintenance using appropriate preventive maintenance procedure/steep to maintain personal computer.

Reference

- Effective preventive maintenance https://www.ccohs.ca/oshanswers/prevention/effectiv.html
- Data sheet https://en.wikipedia.org/wiki/Datasheet
- Cannon service manual
- https://en.wikipedia.org/wiki/Photocopier
- https://en.wikipedia.org/wiki/Printer_(computing)
- https://en.wikipedia.org/wiki/Uninterruptible_power_supply
- https://en.wikipedia.org/wiki/Uninterruptible_power_supply
- https://en.wikipedia.org/wiki/Fax
- https://en.wikipedia.org/wiki/Image_scanner
- Cleaning circuit board https://gesrepair.com/cleancircuit-board/
- solder-onhttps://i0.wp.com/handycrowd.com/wp-content/uploads/2016/04/dry-sonpcbs.jpg?ssl=1
- cleaning methods for electrical preventive maintenancehttps://testguy.net/content/235-Cleaning-Methods-for-Electrical-Preventive-Maintenance
- solder on PCB https://i0.wp.com/handycrowd.com/wp-content/uploads/2016/04/dry-solder-on-pcbs.jpg?ssl=1
- clean circuit board https://gesrepair.com/clean-circuit-board/
- **https://www.youtube.com/watch?v=XQS9Tb8Wsdw**
- **https://www.youtube.com/watch?v=TLjnBtnEWck**

No	Name of trainer	Qualification	Region	E-mail
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