MECHANICS

LEVEL-III

Learning Guide-#52

Unit of Competence: Install and Maintain Basic Pneumatic and Hydraulic Systems

Module Title: Install and Maintain Basic Pneumatic and Hydraulic Systems

Module Code: XXX

LG Code: XXXXX

TTLM Code: XXXXX

LO1*:* Identify Pneumatic system components

Instruction Sheet	Learning Guide #52

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

- Introducing fluid power system
- Introducing basics of pneumatic systems
- Identifying Pneumatic system components
- Distinguishing ISO Symbols of pneumatic system
- Developing Pneumatic system circuit diagram

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

- Understand fluid power system
- Understand basics of pneumatic systems
- Identify pneumatic system components
- Distinguish ISO symbols of pneumatic systems
- Develop simple Pneumatic system circuit diagram

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described from 3 to 5
3. Read the information written in the information "Sheet 1, Sheet 2, Sheet 3, Sheet 4 and Sheet 5".
4. Accomplish the "Self-check 1 and Self-check 2 **in pages -21** and -22 respectively
5. If you earned a satisfactory evaluation from the "Self-check" proceed to **page -23.**

Information Sheet-1	Introducing fluid power systems

1.1 Introduction

Fluid power is the engineering science and technology that deal with the generation of, control, and transmission of energy through the use of pressurized fluids. Fluid power is quite literally the “brute force” behind industry because it is used to push, pull, drive, and regulate virtually all machines used in industry. Fluid power is used in the steering, brake system, and automatic transmissions of cars and trucks. In addition to the automotive industry, fluid power is used to control airplanes and spacecraft, harvest crops, mine coal, drive machine tools, and process food.

All machines require some type of power source and a way of transmitting this power to the point of operation. The three methods of transmitting power are **Mechanical, Electrical and Fluid.** Fluid power is energy transmitted and controlled by means of a pressurized fluid, either liquid or gas. Fluid power can be effectively combined with other technologies through the use of sensors, transducers and microprocessors.

1.2 Advantages of Fluid Power

- Very Accurate
- Power
- Cost effective
- Multi-Speed Capable
- Multi-Motion Capable
- Unlimited Conductive Geometry
- Can be stalled out
- Compact

1.3 General Characteristics of Fluids

- Liquids and gases are both considered fluids
  - Each substance is able to flow
  - Each adjusts its shape to fit the container in which it is held
- Major difference between liquids and gases is compressibility
  - Liquids act much like a solid, i.e **incompressible**
  - Gases change volume when pressurized, i.e. **compressible**

1.4 Pressure Measurements in Fluids

Several pressure scales are used to indicate the pressure of a fluid

- Gauge pressure
- Absolute pressure
- Vacuum
- Head
- Atmosphere

1.5 Fluid systems

- ✓ Fluid systems perform work using energy created by liquids and gases.
- ✓ Fluid power can accomplish the movement of very heavy objects.
- ✓ Examples of fluid power components include **valves**, **hoses**, **air compressors** or **hydraulic pumps**, **cylinders** or **motors**.
- ✓ Fluid power systems are easily operated and controlled, durable, and accurate in their control.

1.5.1 Characteristics of power systems

- ✓ Power can be produced in 3 forms: electrical, mechanical, or fluid.
- ✓ Effort is the force behind movement in a power system.
- ✓ In linear mechanical power this effort is known as force and is measured in pounds.
- ✓ In rotational mechanical power this effort is called torque and is measured in foot pounds.
- ✓ In fluid power, effort is referred to as pressure and measured in pounds per square inch (psi).
- ✓ In electricity, the effort is called voltage and is measured in volts.
- ✓ Rate is a characteristic of power that is expressed in quantity per unit time. All rate characteristics include a quantity (gallons, revolutions, electrons) and a time element (seconds, minutes, or hours).
- ✓ In electrical power the measurement for rate of flow is the ampere.
- ✓ In mechanical rotational systems the rate is measured in revolutions per minute (rpm).
- ✓ A common measurement rate for fluid systems is gallons per minute (GPM).

1.5.2 Basic elements of all power systems

- ✓ An energy source is required for a power system to function.
- ✓ A conversion method is necessary to convert energy so some type of work is produced.
- ✓ A transmission path is needed to move energy to the point where it is supposed to produce work.
- ✓ A storage medium is necessary when power must be stored for use at a later point in time.
- ✓ Protection devices shield components in power circuitry fuses).
- ✓ Advantage gaining devices like transformers to transmit voltages over great distances.
- ✓ Control systems are needed to control the power (on off devices).

- ✓ Measuring devices are needed to monitor power use (meters).
- ✓ Load or output is the final goal of the power system (motors, appliances).

Since fluids exist as either a liquid or a gas, fluid power is a term used to describe both hydraulics and pneumatics. Accordingly, there are two branches of **fluid power systems;**

- ➢ **Pneumatic systems**

  and

- ➢ **Hydraulics systems**

Information Sheet-2	Introducing basics of pneumatic systems

2.1 Basics of Pneumatic systems

Pneumatics comes from the Greek word pneuma, which means 'breath or wind'. It is the *branch of engineering* which deals in *behavior, properties and engineering applications of air.*

Pneumatics is the transmission and control of forces and movements by means of compressed air (as a medium to do work or to transfer force from one point to another).

Pneumatics is a method to transfer energy from one point to another using actuators which are driven by fluids under pressure *(definition).*

Air is compressible:

- it is possible to force an object into a smaller space than it normally occupies.
- *Pneumatics systems* are commonly used where mechanisms require less forces.
- *Pressurized air is a very fast actuation factor. It allows for high speeds of operation (movement), as in the case of the pneumatic cylinders that can reach actuation speeds of 1–2 m/s.*

***Pneumatic** systems are widely used in manufacturing engineering to operate equipment such as packaging machines, automated assembly machines, clamping and lifting devices. There are many other everyday applications where air operated equipment is found, eg for opening doors on buses.*

2.2 Applications of Pneumatic systems

- ✓ Material handling
- ✓ Clamping
- ✓ Shifting

- ✓ Positioning
- ✓ Branching of material flow
- ✓ Packaging
- ✓ Filling
- ✓ Transfer of materials
- ✓ Sorting of parts
- ✓ Stamping and embossing of components

Pneumatic systems

- ✓ Use fluids (air) as working media
- ✓ Convert electrical/mechanical energy into potential energy of fluids (compressor)
- ✓ Transmit power through distribution lines (air hoses)
- ✓ Convert potential energy of fluids (compressed gas) into mechanical energy that turns linear/rotary actuators
- ✓ Pneumatic systems similar to hydraulic systems
- ✓ Use compressed air as working fluid rather than hydraulic liquid
- ✓ 70psi - 150psi, much lower than hydraulic system pressures, much lower forces than hydraulic actuators
- ✓ Energy can be stored in high pressure tanks
- ✓ Open systems, always processing new air

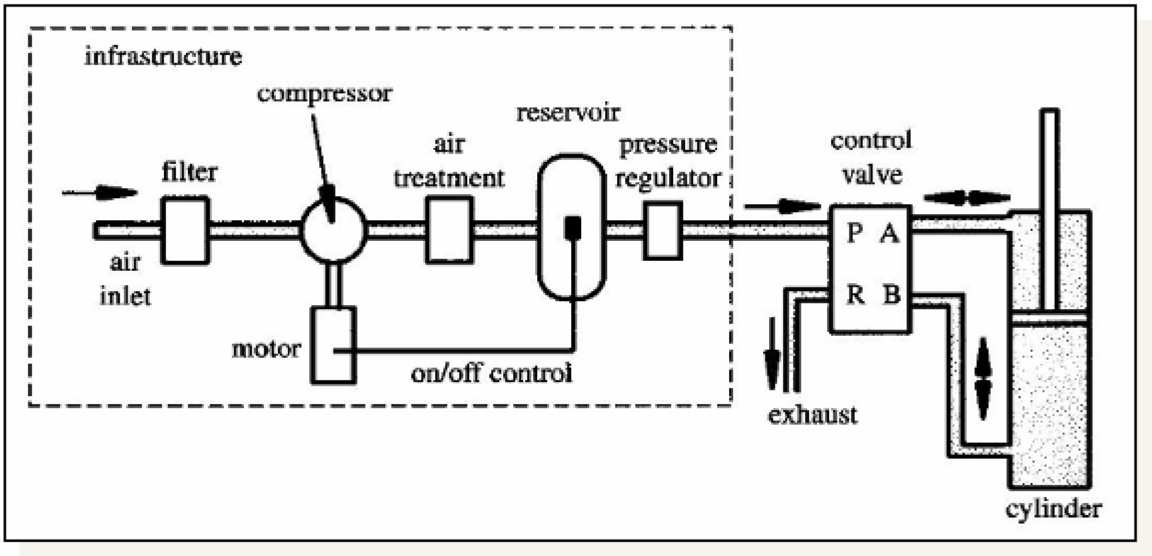


Figure 1: Pneumatic system

Pascal's Law

- Pascal's law states that:

  "a change in the pressure of an enclosed incompressible fluid is conveyed undiminished to every part of the fluid and to the surfaces of its container."
  - Force determined by pressure
  - Speed determined by flow rate

2.3 *Advantages and disadvantages of Pneumatics control systems*

Advantages of *Pneumatics*

- Availability: Air is available everywhere in unlimited quantities and free of cost.
- Transport: Air can be easily transported in pipelines, even over large distances.
- Storage: Compressed air can be stored in a reservoir/tank and removed as required.
- Temperature: Compressed air is relatively insensitive to temperature fluctuations.
- Cleanliness: Unlubricated exhaust air is clean.
- Speed: Compressed air is a very fast working medium. This enables high working speeds to be attained.
- Overload safe: Pneumatic tools and operating components can be loaded to the point of stopping and are therefore overload safe.
- Compressed air does not cause explosion hazards.
- Automation with pneumatics is the cheapest
- Preparation: Compressed air requires good preparation. Dirt and condensates should be removed.
- Speed: As air is compressible; it is difficult to achieve uniform and constant piston speed.
- Force requirement: Compressed air is economical only up to a certain force requirement. Under the normal working pressure of (6 to 7 bar).
- Constant force
- Clean (food industry)
- No return lines needed

- Adaptable infrastructure
- Possible light, mobile pneumatic systems
- Fast system response

Disadvantages of *Pneumatics*

- Difficult to achieve position control (compressible air)
- Noisy (Noise level): The exhaust air is loud (noise). This problem has now, however been largely solved due to the development of sound absorption material and silencers

Limitation of *Pneumatics*

- Air is compressible, therefore precise speed control is difficult
- To do some work pressurized air is must. During compression heat generated necessarily be dissipated, which is wastage
- Leakage causes high pitched noise.
- Can be hazardous

2.4 Energy Flow Diagram of *control systems*

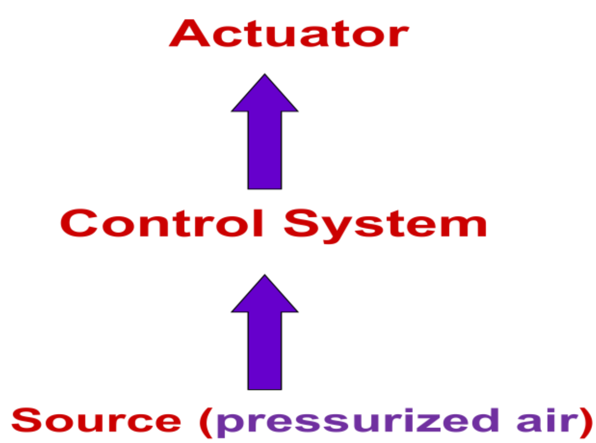


Figure 2: Energy Flow in pneumatic system

Pneumatic system Control:

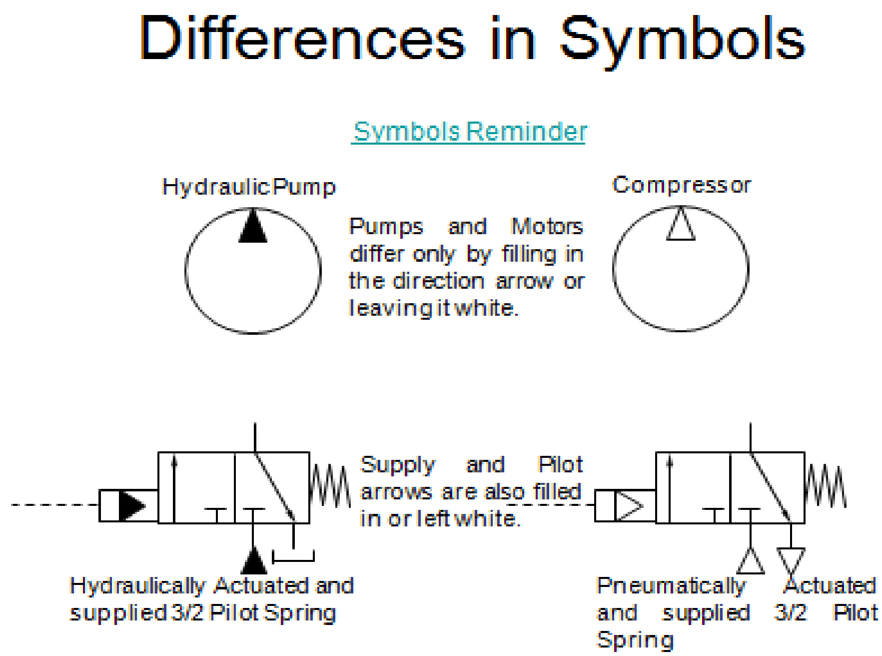
- Clean
- Fast
- Intrinsically Safe
- Overload Safe
- Inexpensive for Individual Components

Pneumatic Dangers

The dangers of the use of compressed air include:

- Air Embolism
- Hose/Pipe Whipping
- Noise
- Crushing/Cutting

Differences in Symbols



Cylinders and other actuators also differ with respect to supply and direction arrows

Many symbols do not change, for example the **Filter** symbol.

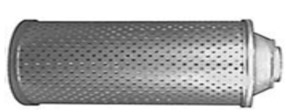


Figure 3: Pneumatic and hydraulic symbols

Remember however that the physical construction is completely different.

For example, hydraulic filters can be Suction **Strainers** (suction side of the pump), **Pressure Filter** (pressure side of the pump) or **Return Filter** (in the return to tank line). Each filter requires different properties.

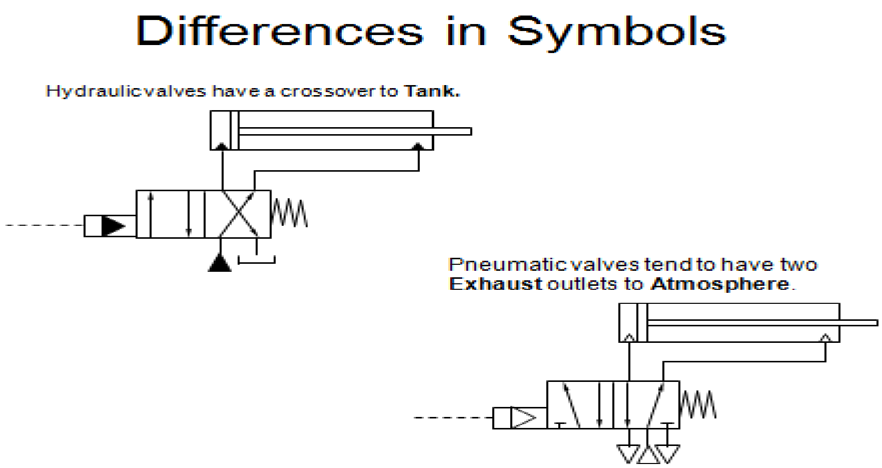


Figure 4: Differences in Medium

Air can hold **Moisture** which can turn into **Condensation** at the **Dew Point.**
The pneumatic components must remove the **Condensation** from the air and provide

Lubrication

Air is safe under a wide range of operating temperatures

Differences in Principles and Properties

Pneumatic systems rely on a supply of **Compressed** air flowing through **Pipes** to **Actuators.** The **Force** for work is produced due to the **Pressure** of the **Air** acting on the **Area** of the actuator. Air is **Compressible.**

Gas laws such as **Boyle's and Charles's** Laws govern **medium** behaviour

Actuator demand is measured in **m^3 per hour** or operation

Compressor output is measured in m^3 per hour **Free Air Delivery** (FAD)

Both Hydraulics and Pneumatics are described with **Pascal's Law** and **F=PA**

Differences in Pressure and Force

Pneumatic Pressures and Forces

- Produced at 10Bar
- Used at 0~6 Bar
- Forces up to 5000Kg

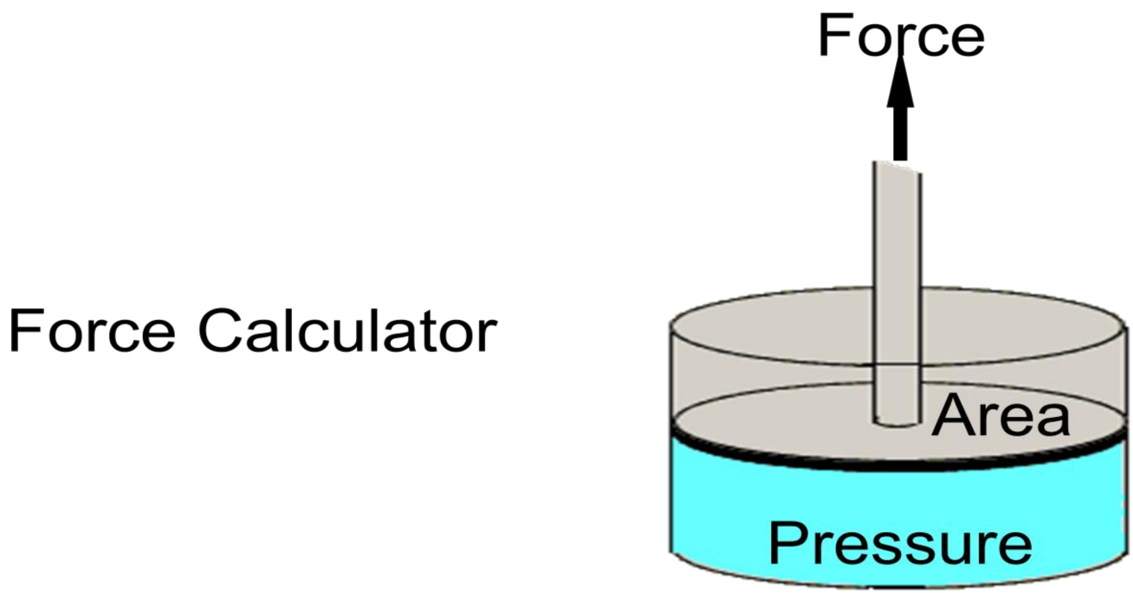


Figure 5: Pascal's principle

Information Sheet-3	Identifying Pneumatic system components

3.1. Basic Pneumatic system components

The basic pneumatic system components are:

1. **Power input device:**
   - ✓ The compressors and motor together are called the power input device; the compressor provides power to the pneumatic system by sucking air from the reservoir.
2. **Control device:**
   - ✓ Valves control the direction, pressure, and flow of the pneumatic air from the compressor to the actuator/cylinder.
3. **Power output device:**
   - ✓ The pneumatic power is converted to mechanical power inside the power output device.
   - ✓ The output device can be either a *cylinder which produces linear motion* or a motor which *produces rotary motion*.
4. **Source:** medium used in pneumatic systems to transmit power.
   - ✓ Compressed Air
5. **Conductors:**
   - ✓ The conductors are the tubes or hoses needed to transmit the air between the pneumatic components
6. **Pneumatic Motor :**
   - ✓ Receives power from moving air to transfer *pneumatic power to mechanical rotating force*.
7. **Cylinder:**
   - ✓ transfers pneumatic power into mechanical movement in one or two directions only.
   - ✓ Single-acting - works in one direction only.
   - ✓ Double-acting- pushes and pulls.

8. **Shaft:** round bar that is extended from and retracted into a pneumatic cylinder**.**
9. **Seal:** Found in hydraulic components; function is to keep fluid from leaking between moving and non-moving parts
10. **Check Valve:** Restricts flow of fluid to only one direction; allows pressure to build up or be maintained.
11. **Spool Valve**: Controls direction of flow of fluid in a hydraulic /pneumatic system to cause the different parts of the system to function.

The above basic components can be summarized as

1. Receiver
2. Compressor
3. Electric Motor (prime mover)
4. Valves
5. Conductors (pipe, tubing, and hose)
6. Actuators

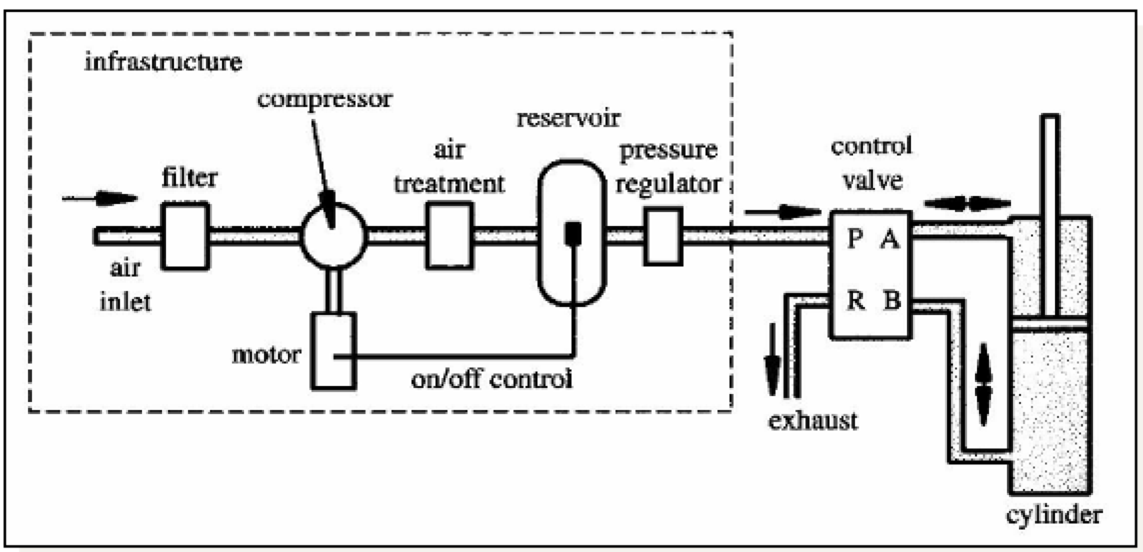
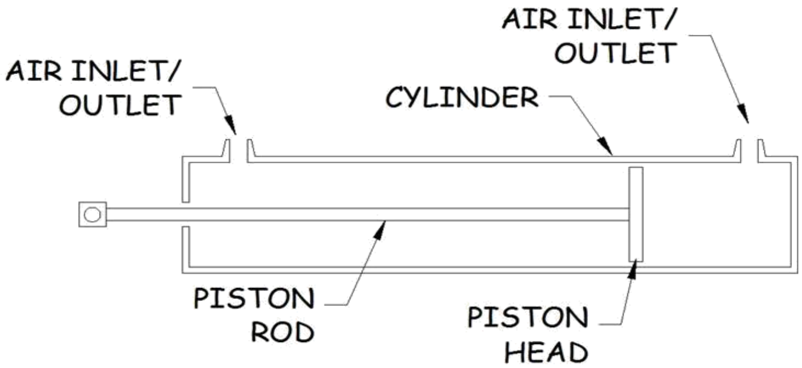


Figure 5: detail elements of Pneumatic system

4.1. ISO Symbols of pneumatic system components

Cylinder – Device which uses pressurized air to move a piston linearly.



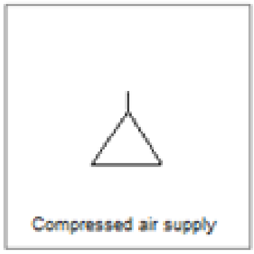
Circles/Semi Circles

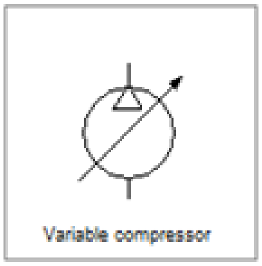
Circles generally represent devices that can deliver or use air.

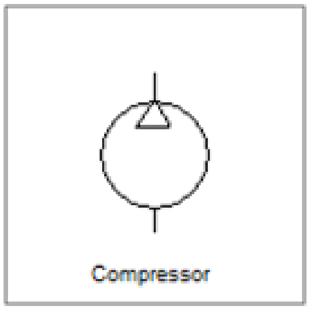
Unidirectional Fixed Displacement compressor

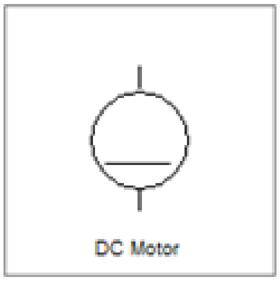
Compressed air Supply

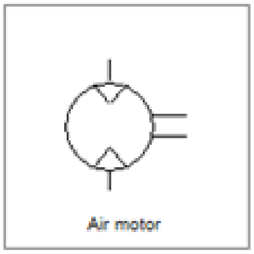
Unidirectional Variable Displacement Compressor

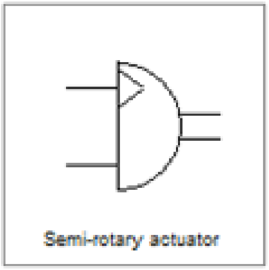












Diamonds

Symbols in diamonds condition the oil in some way. **Heating, cooling, filtering etc.**

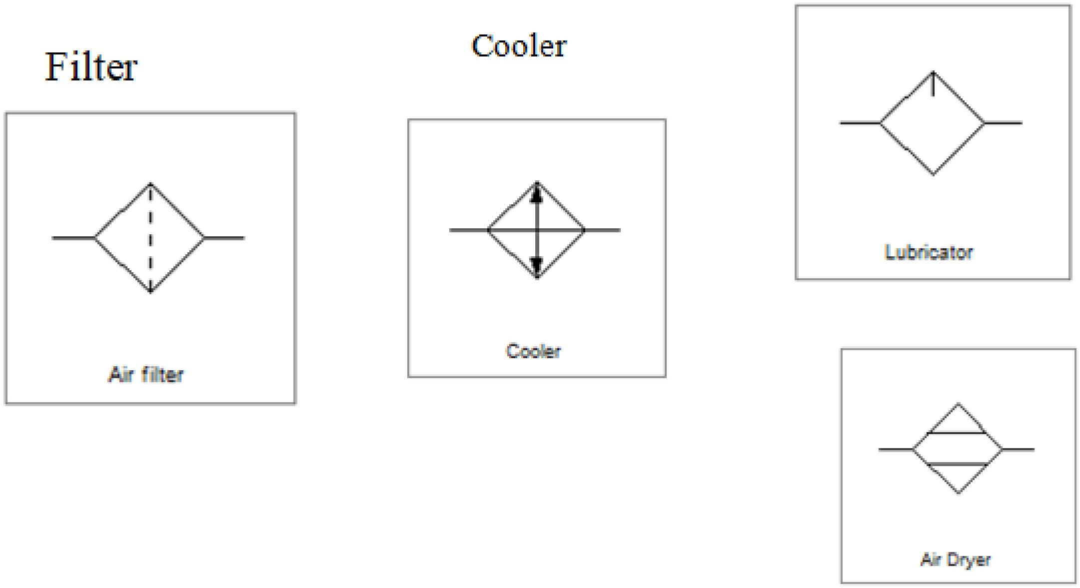


Figure 6: ISO symbols of Pneumatic elements

5.1 Pneumatic system circuit diagram (Schematic Symbols)

Simple pneumatic power transmission from one point to another is shown in figure below:

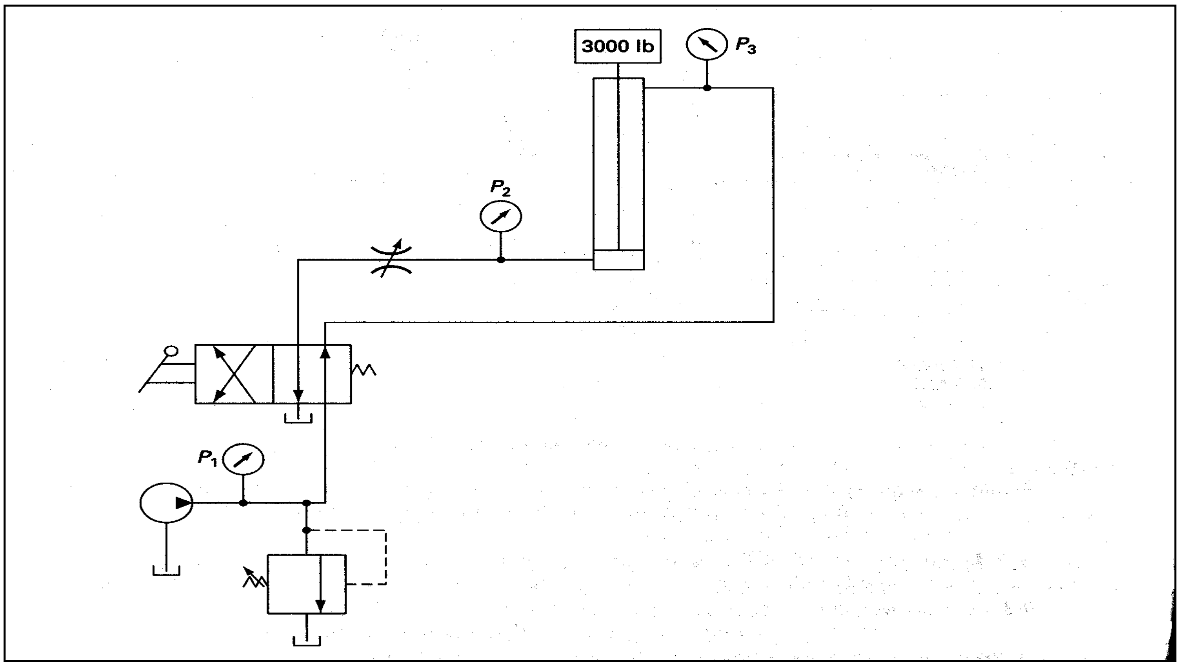


Figure 5 (a): Simple pneumatic circuit system

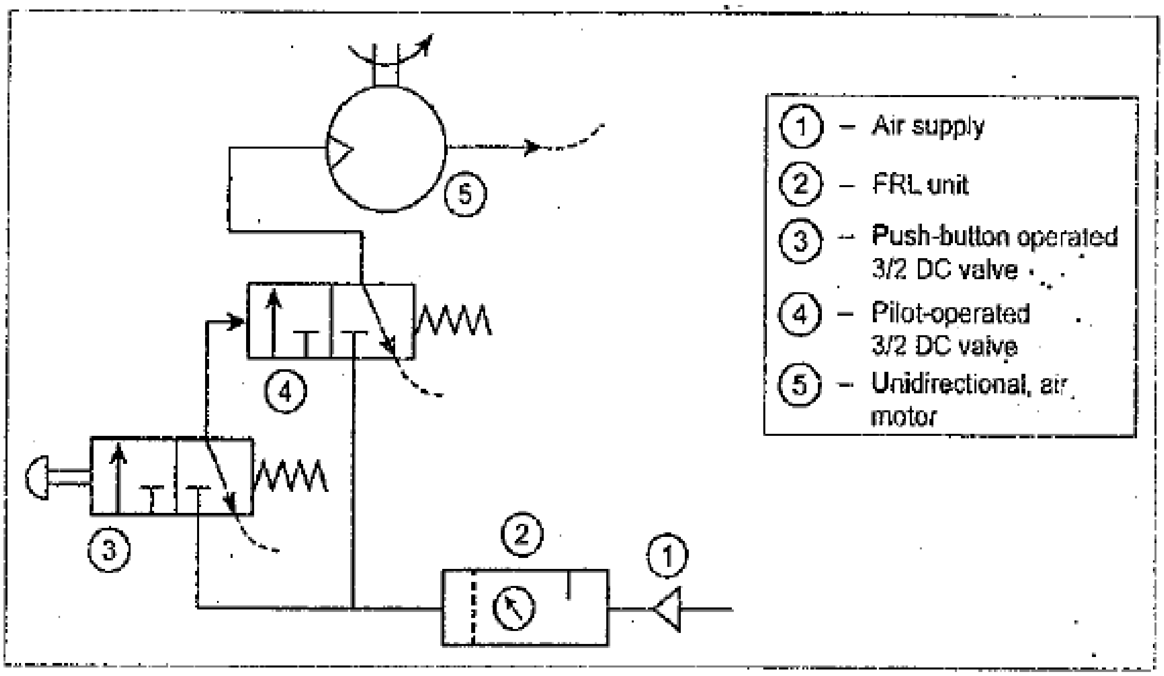


Figure 5 (b): Simple pneumatic circuit system

Self-Check -1	Check out Test

Test I: Open ended questions

Directions: **Questions to Ask Yourself** **(each question have 5.pts)**

1. State the basics of pneumatics
2. What interconnects the components in a pneumatic system?
3. Discuss the function of each pneumatic system elements
4. Describe the operation of a basic pneumatics system.

Satisfactory- above 15 points **Unsatisfactory - below 10 points**

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

Answer Sheet

Score = ___________
Rating: ____________

Name: _________________________ Date: _______________

Self-Check -2	Check out Test

Test II: Subject matter

Directions: **Questions to Ask Yourself (each question have 4.pts)**

1. Show the symbolic representation of Compressors

2. Show the symbolic representation of filters

3. Show the symbolic representation of 2/3 directional control valve

4. Show the symbolic representation of pneumatic actuators

Satisfactory- above 10 points **Unsatisfactory - below 10 points**

1.

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

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

MECHANICS

LEVEL-III

Learning Guide-#53

Unit of Competence: Install and Maintain Basic Pneumatic and Hydraulic Systems

Module Title: Install and Maintain Basic Pneumatic and Hydraulic Systems

Module Code: XXX

LG Code: XXXXX

TTLM Code: XXXXX

LO2: Install Pneumatic Components

Instruction Sheet	Learning Guide #53

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

- Introducing to Pneumatic system installation
- Installation of air compressor accessories and fittings
- Installing pneumatic system controlling elements
- Installing source transmission elements (hoses)
- Installing pneumatic actuating elements

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

- Install air compressors
- Install air compressor accessories and fittings
- Install pneumatic system controlling elements
- Install source transmission elements (cables)
- Install pneumatic actuators

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described from 3 to 6
3. Read the information written in the information "Sheet 1 and Sheet 2
4. Accomplish the "Self-check 1, Self-check 2 " **in page -31, and 32** respectively.
5. If you earned a satisfactory evaluation from the "Self-check 1 and 2" proceed to "Operation Sheet 1," **in page -33.**
6. Do the "**LAB** test" of the operation sheet 1**in page – 33** (if you are ready).

Information Sheet-1	Introducing to Pneumatic system installation

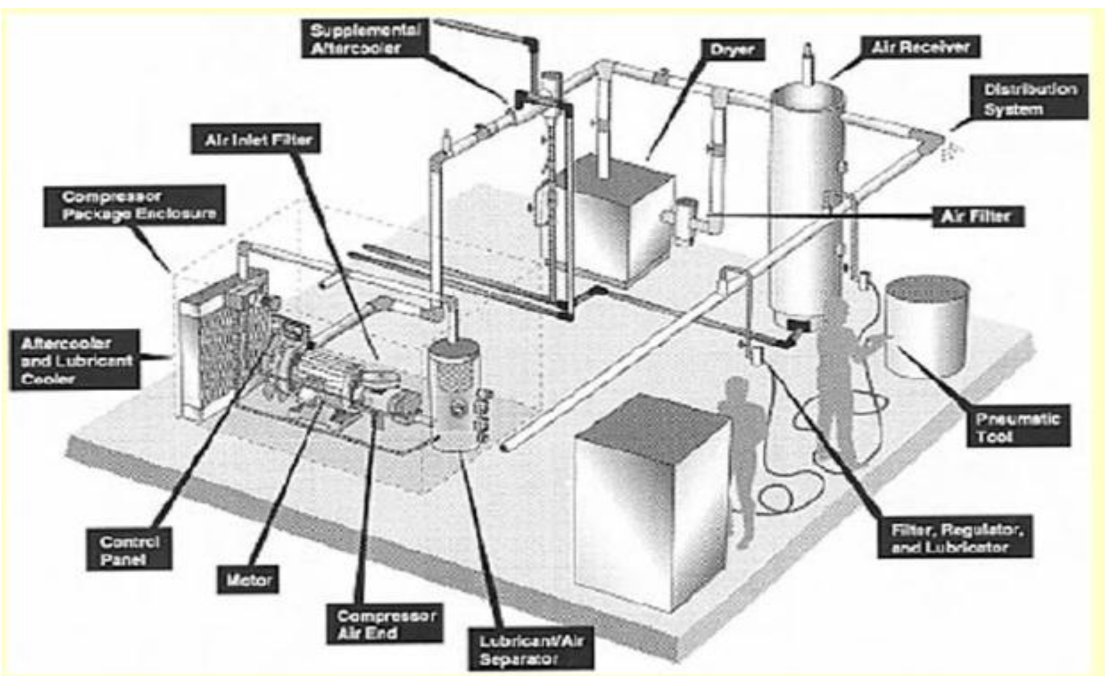
2.1 Installation of Pneumatic systems

Pneumatic installation can be categories into two types:

1) Plant installation
2) System/machine installation

Plant installation is normally for compressed air generation and distribution. It involved distribution of compressed air from compressor room to all pneumatic component via systematic piping system.

Machine installation is for connecting all pneumatic actuators to all control valve using pneumatic hose/tube for specific operation. It also include connection to the main piping system



1) Air Compressor, 2) Dryers, 3) Distribution, 4) Regulators, 5) Control Valves, 6) Filters, 7) Cylinders, 8) Air tools

Pneumatic piping, hoses and connections for plant installation

The various end devices in a pneumatic system are linked to the air receiver by pipes, tubes or hoses.

• In many schemes the air supply is installed as a fixed service similar, in principle, to an electrical ring main allowing future devices to be added as required.

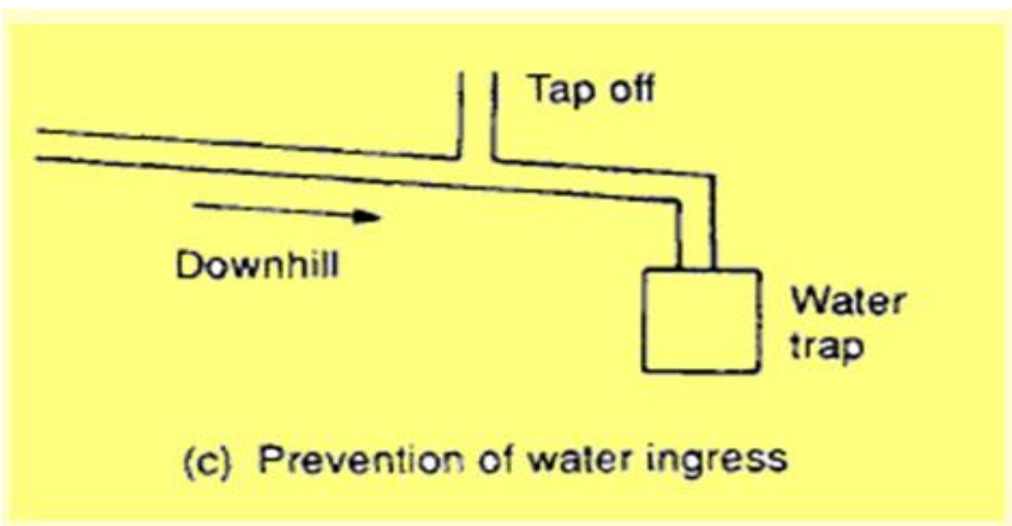
•Two type of compressed air distribution:

1) Manifold

2) Ring

Pneumatic systems are vulnerable to moisture and, to provide drainage, the piping should be installed with a slope of about 1% down from the reservoir.

A water trap fitted at the lowest point of the system allows condensation to be run off, and all tap offs are taken from the top of the pipe to prevent water collecting in branch lines



• The pipe sizing should be chosen to keep the pressure reasonably constant over the whole system.

The pressure drop is dependent on:

1. Maximum flow

2. Working pressure

3. Length of line

4. Fittings in the line (e.g., elbows, T-pieces, valves)

5. The allowable pressure drop.

•The aim should be to keep air flow non-turbulent (laminar or streamline flow).

• Pipe suppliers provide tables or nomographs linking pressure drops to pipe length and different pipe diameters.

Pipe fittings are generally specified in terms of an equivalent length of standard pipe (a 90 mm elbow, for example, is equivalent in terms of pressure drop to 1 metre of 90 mm pipe).

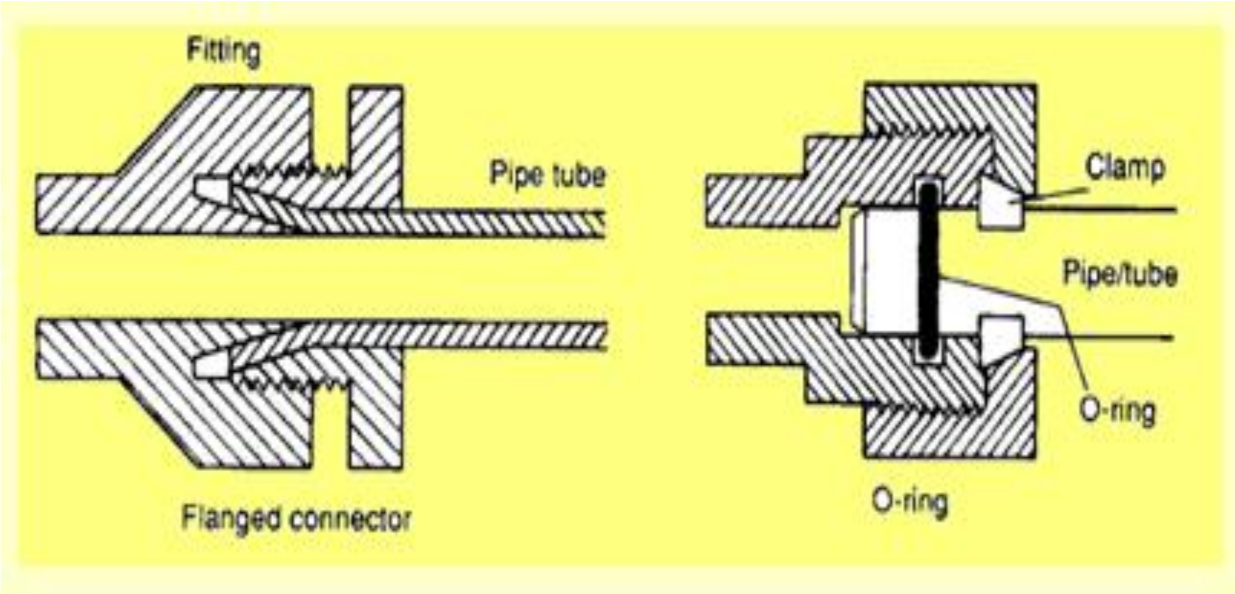
If an intermittent large load causes local pressure drops, installation of an additional air receiver by the load can reduce its effect on the rest of the system.

The local receiver is serving a similar role to a smoothing capacitor in an electronic power supply, or an accumulator in a hydraulic circuit.

If a pneumatic system is installed as a plant service (rather than for a specific well-defined purpose) pipe sizing should always be chosen conservatively to allow for future development.

Black steel piping is primarily used for main pipe runs, with elbow connections where bends are needed

Connections can be made by welding, threaded connections, flanges or compression tube connectors.



•Welded connections are leak-free and robust, and are the prime choice for fixed main distribution pipe lines.

•Threaded pipe connections must obviously have male threads on the pipes, and are available to a variety of standards.

•A pipe run can be subject to shock loads from pressure changes inside the pipe, and there can also be accidental outside impacts.

•Piping must therefore be securely mounted and protected where there is a danger from accidental damage.

•In-line fittings such as valves, filters and treatment units should have their own mounting and not rely on piping on either side for support.

Information Sheet-2	**Installing pneumatic system components**

2.2 Installing pneumatic system components

Installing of pneumatic system includes the following components

1. Compressor intakes and foundations;
2. After coolers;
3. Receivers;
4. Dryers;
5. Pipe installation and support;
6. Tubing and hose fittings;
7. System installation

Pneumatic machines need five basic components to make, store, control, move, and use compressed air:

1. A **compressor**—makes air.
2. A reservoir (or receiver)—stores air.
3. One or more **valves**—control air.
4. A circuit—moves air between the other components.
5. An **actuator** or motor—uses air to do something.

1. Air compressors

Air Compressor Installation Procedure

1. Choose the most appropriate and secure location to position your **compressor**.
2. Ensure the space is enough for your operations and tool applications.
3. Choose the required hose lengths and fittings.
4. Stabilize your **compressor** and lower vibration noise by setting it on isolator pads.

Figure 6: Air Compressor Installation Procedure

Self-Check -1	Check out Test

Test I: Open ended questions

Directions: **Questions to Ask Yourself (each question have 3.pts)**

1. **Describe the proper installation of the compressor and its auxiliaries.**
2. **Describe the installation of after coolers, receivers, and dryers.**
3. **Explain the correct procedures for installing pipes, tubes, and hoses in pneumatic systems.**
4. **Describe the installation of control valves, solenoid coils, and cylinders.**

Satisfactory- above 8 points **Unsatisfactory - below 6 points**

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

Answer Sheet

Score = ___________
Rating: ____________

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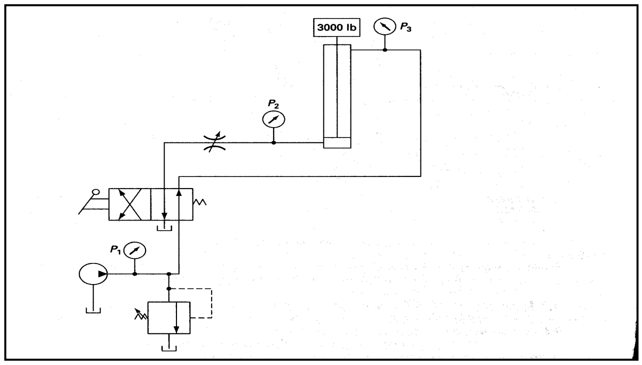
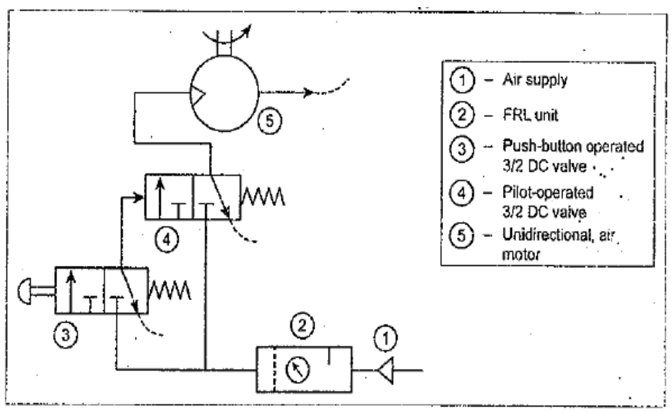
Self-Check -2	Check out Test

Test II: Lab test

Directions: Do the following two pneumatic circuits (each question have 5.pts)





Satisfactory- above 8 points **Unsatisfactory - below 8 points**

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

Answer Sheet

Score = ___________

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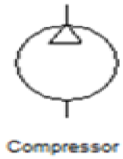
Name: _________________________ Date: _______________

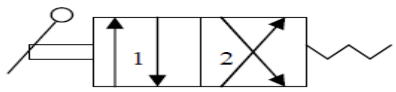
Operation sheet -1	Pneumatic system operation

Pneumatic system operation

Step 1: Place the right air compressor at the designed/appropriate position

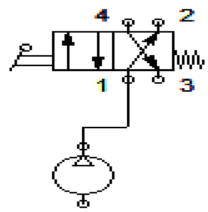


Step 2: Place an appropriate directional control element (Valve) with its actuation method at the right position

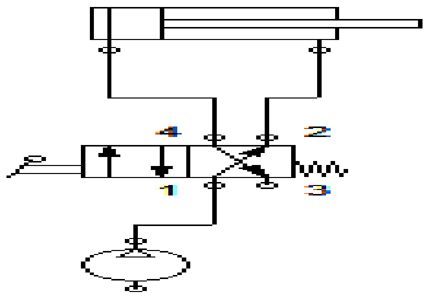


Step 3: Place the pneumatic actuator at the design position

Step 4: Connect the air compressor outlet port with directional control valve inlet port



Step 5: Connect all the directional control valve working ports with the pneumatic actuator (linear or rotary and single or double) by the pneumatic hoses



Step 6 (**optional**): Control the pressure of the system using the pressure control valves

Step 7 **(optional)**: Control the speed of the actuators using the flow control valves

Learning Guide-#54

Unit of Competence: Install and Maintain Basic Pneumatic and Hydraulic Systems

Module Title: Install and Maintain Basic Pneumatic and Hydraulic Systems

Module Code: XXX

LG Code: XXXXX

TTLM Code: XXXXX

LO3: Maintain Pneumatic system components

Instruction Sheet	Learning Guide #54

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

- Introducing to Pneumatic system maintenance
- Maintaining air compressor accessories and fittings
- Maintaining pneumatic system controlling elements
- Maintaining source transmission elements (cables)
- Maintaining pneumatic actuating elements

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

- Maintain air compressor accessories and fittings
- Maintain pneumatic system controlling elements
- Maintain source transmission elements (cables)
- Maintain pneumatic actuators

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described from 3 to 4
3. Read the information written in the information "Sheet 1, Sheet 2, Sheet 3, Sheet 4 and Sheet 5".
4. Accomplish the "Self-check 1" **in page -50**.

Information Sheet-1	Maintenance of Pneumatic system

3.1 Maintenance of Pneumatic system

In pneumatic systems, regular maintenance of all the components is of utmost importance so as to ensure that the system works at its complete potential. If not properly taken care of, frequent damages and breakdowns are bound to happen, and this will in turn reduce the life of the equipment and will incur additional costs.

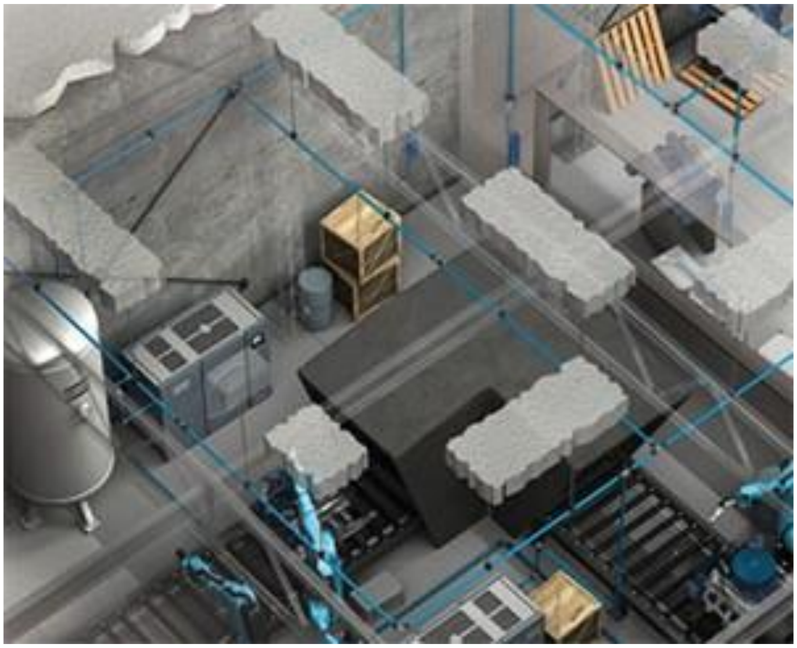
Regular maintenance will allows you to find the damaged or malfunctioning parts of the system and will also allow you to take timely measure for the same.

Thus, companies should ensure that they have a special team to manage the maintenance of the pneumatic systems and take steps to further enhance their knowledge about the latest in pneumatic systems to ensure adequate maintenance with the best and latest of knowledge.

To ensure that the maintenance efforts are delivering the required results, it is very important that your pneumatic system is designed with adequate knowledge by experienced professional designers.

The main problem with any **pneumatic system** is its pipeline and air layout. Thus the designer should give adequate important to the laying of the pipeline network and air flow to ensure that the risk of malfunctioning is minimal.

Another important thing while designing the pneumatic system is, that the system should be designed as simple as possible. The easier they are to handle the lesser the number of malfunctions.



During maintenance too, proper inspection of the pipeline, airways and filters should be done to reduce the risk of breakdown. If the pipes, **valves, cylinders**, etc. are found to be defective, proper steps must be taken to repair or replace the parts. The maintenance schedule should be as such that it should give due importance to the areas that frequently malfunctions.

Other problems like the resistance of flow or pressure drop is not witnessed that frequently, but they too should be checked regularly to further reduce the chances of breakdowns.

Importance of Daily Maintenance

Yes, as compared to other mechanical systems, pneumatic systems are far better as far as the problems are concerned, but that doesn't mean that they do not require maintenance. Problems that do come up every now and then are not that difficult to resolve as other systems, but only when proper maintenance and care is taken.

Pneumatic systems result in less troubles only when the maintenance is carried out on a daily basis. Thus, daily maintenance is of utmost importance to ensure that the system runs in its best possible state.

There are a number of guidelines that can make the daily maintenance of pneumatic systems easier, let us check some of the guidelines:

- Always ensure that you have an accurate circuit as well as the functional diagram of the pneumatic system. If any changes are made after installation, ensure that they are made in the directions as well.
- Do take care that the impulse valves of the system is protected from excess of dirt, mechanical shocks and cooling water.
- Imprints of the elements and the units should be accurate and easily visible.
- The valve openings that are given by the manufacturers should only be used.
- Do not drill the elements of the system for a new opening.
- If you need an additional opening, discuss it with the manufacturer and they might design a custom system for you.
- The service unit of the system should be clearly visible and easy to service. If possible, also ensure that it is placed higher that the other elements.
- Do not increase the throttle that what is needed and specified by the manufacturer.
- If you are dismantling the cylinders or valves, do take care of its sealing materials. Even while assembling them again, ensure that they are properly placed.
- Actuated valves, though appear easy to work with, but are known to cause serious problems. Thus, it is good to ensure that they are controlled in the proper direction and at the required speeds only.

Leakage

Leakage is another important and most common aspect of any pneumatic system. If left undetected for a long period, problems like enhanced load on the system, wastage of compressed air, increased maintenance and operating costs without fruitful results, and even the risk of loss in quality of production can be experienced.

Though, it is a common problem and can be very devastating if left for a long period, air leakage is actually very easy to detect and stop.

It's easy due to the nature of air. It escapes by making noise, which makes it very easy to notice in any system. If the leakage is very small and is not making any sound of escaping air, try to apply soap water solution to the area.
If there is no leakage the soap water will remain as it is, but if there is an air leakage, it'll start producing air bubbles.

Once detected, you can simply tighten up the glands, **fittings** or the joints. If the leakage is major, you can think about completely replacing the damaged part with a new one. There are also many bonding products available in the markets that are especially designed for commercial use, you can even use them to eliminate the leakage.

3.2 Maintaining pneumatic system Elements

Pneumatic components and systems normally require very little maintenance. Regular inspections with minor adjustments are a form of preventive maintenance and will prolong the operating life of most pneumatic controls.

The following schedule (weekly, monthly, annual) is intended as a guideline. Experience and operating conditions will determine actual schedules. Refer to OEM datasheets for specific maintenance instructions.

Action	Schedule
Drain air line filters. Check operation of the water traps.	Weekly, or more often as needed
Check for and seal air leaks.	Every four weeks, or more often as needed
Add lubricant to mist lubricators.	Every four weeks, or more often as needed
Externally clean components and actuators.	Every four weeks
Lubricate cylinders and pivot points. Check and adjust component movements.	According to mechanical maintenance recommendations
Replace air filters.	Every six months
Replace or clean plugged silencer.	As needed

Look at the different equipment of the pneumatic system during the inspection. Carefully examine the **pipes, pneumatic valves, pneumatic timers, and pneumatic cylinders**. If anything is not working properly, it should be attended to immediately.

When an inspection team is assembled, they should have a set of guidelines to following when checking the pneumatic system. During the review, make sure that there are an accurate circuit and a functional diagram. Clear the impulse valves of all dirt, mechanical shocks, and cooling water.

The imprints of the elements and the units should be visible and accurate. During the inspection, only use the valve openings given by the manufacturer. At times, the dismantling of the cylinders or valves is required. If this happens, take care of the sealing materials.

Cleaning

When cleaning, do not use cotton waste or other cloths that have lint. When changing a cylinder, plug the hose ends to keep impurities out. When you are cleaning pneumatic cylinders, give special attention to blind ends and piston rods with links.

Seal lubrication

Usually seals are the components most subject to premature wearing. A seal wears out prematurely or is damaged for the following reasons:

- insufficient lubrication
- careless installation
- defective slide surface
- impurities

If valve or cylinder seals have to be renewed, lubricate them and the slide surfaces of the components with silicon or paraffin grease. Be careful not to apply too much lubricant since too thick a layer will get "lumpy," which may prevent proper functioning of a seal.

3.2.1. Maintaining air compressors

Compressors have their own maintenance requirements. Many are belt driven, and require belt condition and tension to be checked at regular intervals. Crankcase oil level and the air breather should also be checked.

The compressor is normally sized for the original capacity plus some reserve for future additions. A compressor will thus start life on a low duty cycle, which increases as further loads are added. When compressor capacity is reached, the compressor will be on 100% duty cycle. Any additional load results in a fall of system pressure in the receiver.

Duty cycle of the compressor thus gives a good indication of the health and reserve capabilities of the systems.
Compressor efficiency is determined largely by the condition of valves, piston tings and similar components subject to friction wear.

These should be examined at intervals given in manufacturers' instruction manuals.
Other common pneumatic maintenance checks are validation of safety valve operation on the receiver, replenishment of oil in the air lubrication and drainage of water from air dryers.

System pressure should be recorded and checked against design values. Deviations can indicate maladjustment or potential faults.

Too high a pressure setting wastes energy and shortens operational life. Too low a pressure setting may pressures below that needed by actuators, leading to inefficient or no movement.

Filters are of prime importance in pneumatic systems. Obviously filters should be changed before they become blocked. Inlet air filters on pneumatic systems also need regular cleaning and record should be kept of filter changes Seals and bushing in cylinders, for example, require regular checking and replacement if damaged.

Cylinder rods should be examined for score marks which can indicate dust ingress.

Where the device examined follows a sequence, the operation should be checked to ensure all ancillary devices, such as limit switches, are operating.

The time to perform sequences may be worth recording as a lengthening of sequence times may indicate a possible developing fault due to, say leakage in a cylinder.

The person maintaining air systems in today's modern plant must know the following:

- Compressed air safety
- The function of each pneumatic component. This includes compressors, aftercoolers, dryers, cylinders, valves, filters, regulators and lubricators.
- The effects of water vapor and moisture in an air system and how to control it.
- How temperature affects pressure and air volume.
- How to adjust the system control devices such as pressure switches, regulators, lubricators and dew points for dryers.
- How to troubleshoot and test compressors, receivers, relief valves, dryers, valves and cylinders.
- How to read the pneumatic symbols for troubleshooting from the schematic.

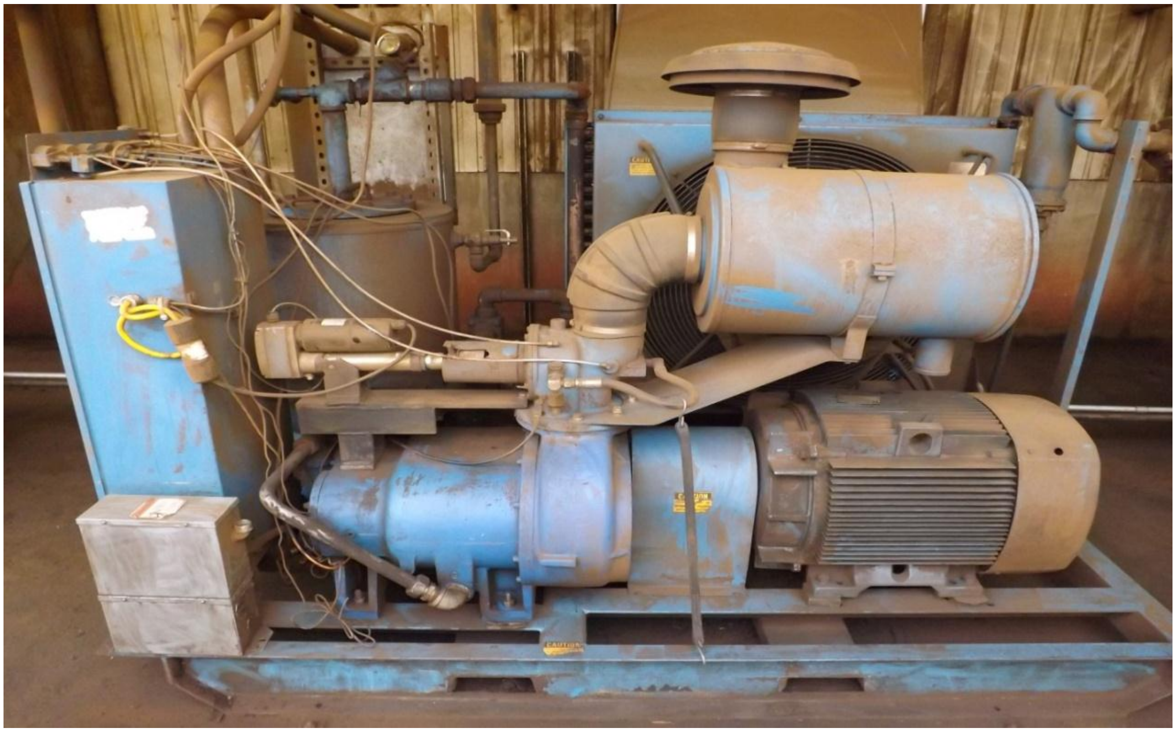


Figure: power pack of pneumatic system

Most important, maintain clean fluid and filters. Compressor has check valves, vanes, pistons and gears that can be scoured and damaged by contaminants. This will result in inefficient sucking and cause wear on other parts of the equipment.

3.2.2. Maintaining pneumatic system controlling elements

Valves:

Valves consist of tight-fitting components that block or direct flow. These can be abraded and leak (internally), resulting in low pneumatic pressure. Contaminants can lodge in valves and restrict flow. Again, maintain clean compressed air to keep valves in good working order.

3.2.3.Maintaining compressed air transmission elements

The next aspect of routine maintenance is checking the hoses, lines, fittings and seals. Inspect these components to determine if they have been damaged and ensure they are in good condition and in the right location.

- **Inspect hoses and lines.** Plastic/Metal lines may be dented from falling tools, contact with other equipment or myriad other reasons. Inspect lines for cracking, cuts or dents that restrict flow or cause pressure leaks. Hoses can be damaged in the same manner, as well as from overheating, extended wear and defective manufacturing. Look for crimped or collapsed hoses that could be restricting flow. The hose could be internally damaged, causing pieces of the hose to enter the pneumatic system and contaminate it.
- **Check the hose routing.** Sometimes brackets break and hoses and lines end up where they are not supposed to be. They can be pinched, kinked, overstretched or chafed.
- **Inspect hoses at flex points.** Operate the pneumatic system and observe the flex point for kinking or stretching.
- **Check all fittings on hoses to make sure they are snug.** If you notice leakage at a fitting, tighten it. Be careful to not overtighten or thread damage will result.
- **Check couplings.** Always keep these points clean, they are a major source of contamination. Make sure that caps are in place when the couplings are not used and replace any caps that do not fit tightly. Before connecting any lines, thoroughly clean each coupling.
- **Keep the hoses clean by washing machinery on a regular basis.** This will also help to reduce compressed air temperatures.

If a hose or line is damaged, make sure that any replacements are of the same length, size and wall thickness. Refer to the service manual for specifications.

3.2.4. Maintaining pneumatic actuating elements

Cylinders and motors

Cylinders have seals and rings that can be damaged by excess pressure and contaminants in the compressed air. Once again, be sure that your compressed air is clean. Check the points where the cylinder rod moves in and out of the cylinder housing for leaks. Check the length of the cylinder rods for any dings, dents or other damages that could allow air and pressure to escape.

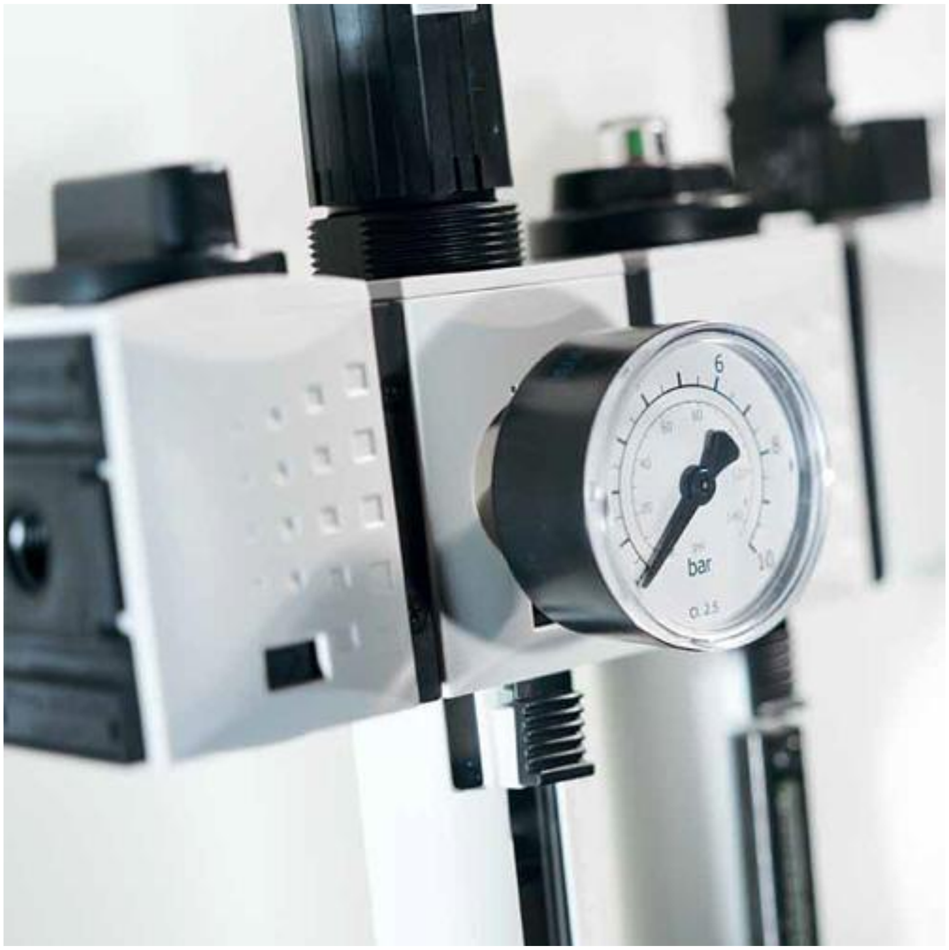
A cylinder is designed to take loads along its axis only. Side loads can decrease cylinder life by causing excess wear on seals and the rod.

With pneumatic motors, as with compressor, your primary maintenance consideration is clean compressed air. The gears, vanes and pistons can be abraded by contaminants, resulting in pressure loss. Before each use, check the drive shaft of the motor for any damage or leakage. Be sure that motors are started and operated at the correct rpm.

3.2.5. Maintaining Other pneumatic system components

Filter Regulator Lubricator (FRL)

If the maintenance is well-planned and done by an expert on a daily basis, pneumatic systems are known to last for a very long time.



The major reasons like dirt, low lubrication oil, damage in the glands or valves etc. can be taken care of by ensuring the FRL of the system is in good condition.

FRL is a component that is designed to prevent dirt from getting into the system and to also ensure that adequate amount of lubrication is available in the system at all times, so as the reduce the damage due to friction. Thus, if the FRL is in good condition, whole pneumatic system can function flawlessly.

The maintenance of a pneumatic system is incredibly important. If not maintained properly, it will not work to the best of its ability. Without routine checkups and inspections, the pneumatic system can quickly break down and become damaged. Constant breakdowns and damages will decrease the life of the system and will wind up costing the company additional funds.

All businesses should have a task force of individuals that will regularly check the pneumatic system. These checkups will account for any malfunctioning equipment. The checkups will allow for damages to be fixed, so they do not get any worse.
The pipeline and air layout of the pneumatic system are what cause the most problems. The inspection team should be mindful to pay close attention to these areas of the system. Focusing on these areas ensures the risk of malfunctioning is low.

Self-Check -1	Check out **Test**

Test I: Open ended questions

Directions: **Questions to Ask Yourself** **(each question have 4.pts)**

1. What is mean pneumatic system maintenance?

2. Discus the types of pneumatic system maintenance?

3. What are the most sensitive pneumatic system components?

4. Describe the maintenance procedures for **FRL** system?

Satisfactorya. **above 12 points** **Unsatisfactory - below 10 points**

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

Answer Sheet

Score = ___________
Rating: ____________

Name: ___________________________ Date: ________________

MECHANICS

LEVEL-III

Learning Guide-#55

Unit of Competence: Install and Maintain Basic Pneumatic and Hydraulic Systems

Module Title: Install and Maintain Basic Pneumatic and Hydraulic Systems

Module Code: XXX

LG Code: XXXXX

TTLM Code: XXXXX

LO4: Identify hydraulic system components

Instruction Sheet	Learning Guide #55

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

- Introducing basics of hydraulic system
- Identifying Hydraulic system components
- Distinguishing ISO Symbols of hydraulic system
- Developing Hydraulic system circuit diagram

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

- Understand basics of hydraulic systems
- Identify hydraulic system components
- Distinguish ISO symbols of hydraulic systems
- Develop simple hydraulic system circuit diagram

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described from 3 to 4
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 and Self-check 3 " **in page -67, 68, and 69** respectively.

Information Sheet-1	Introducing basics of hydraulic systems

4.1. Basics of hydraulic systems

Hydraulic *means fluids (oil or water)*. It is the *branch of engineering* which deals in *behavior, properties and engineering applications of liquid.* Hydraulics *is the transmission and control of forces and motions through the medium of fluids* from one point to another. Liquid is incompressible: When a "squeezing" force is applied to an object, *it does not change to a smaller size* (possesses this physical property).

Hydraulic (pressurized liquid) systems are used where greater amounts of power are involved, a good example of this being the linear actuators that move the arms on excavators and other types of earth-moving equipment.

Hydraulic *systems* are commonly used where mechanisms require large forces and precise control. Because liquid does not compress, it transfers all the force and enables precise movement.

Examples

- Vehicle power steering and brakes
- Hydraulic jacks
- Heavy earth moving machines

4.2. Applications of Hydraulic system

- Lot of hydraulic applications in manufacturing, transportation, and construction sectors.
- industrial applications:
  - ✓ Machine tool manufacturing
  - ✓ Press manufacturing
  - ✓ Plant construction
  - ✓ Vehicle manufacturing
  - ✓ Aircraft manufacturing
  - ✓ Shipbuilding

- ✓ Injection molding machines

4.3. Use of Hydraulics fluids

- primary purpose:
- ✓ to transmit force from one place to another i.e Power transmission (pressure and motion transmission).
- secondary tasks:
- ✓ Lubricate contact surfaces within the system to avoid friction and wear
- ✓ Provide sealing of components, where tight clearances are involved.
- ✓ Remove heat generated within the system (Heat transport- away from the location of heat generation, usually into the reservoir).
- ✓ Protect system components against rust, oxidation and corrosion.
- ✓ Prevent foaming when subjected to turbulence.
- ✓ Transport of particles to the filter
- ✓ Protection of surfaces from chemical attack, especially corrosion

Hydraulic Systems

- ✓ Use fluids (Hydraulic Oil/water) as working media
- ✓ Convert electrical/mechanical energy into potential energy of fluids (pump)
- ✓ Transmit power through distribution lines (pipes)
- ✓ Convert potential energy of fluids (oil) into mechanical energy that turns linear/rotary actuators
- ✓ Move large loads by controlling high-pressure fluid in distribution lines and pistons with mechanical or electromechanical valves
- ✓ 1000psi – 3000psi
- ✓ Closed systems, always re circulating same fluid

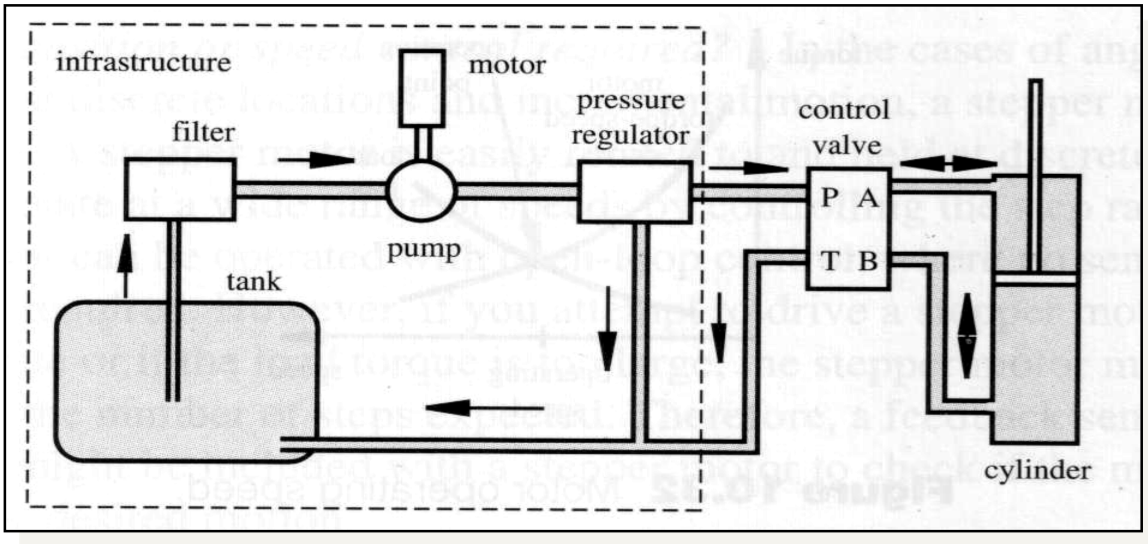


Figure1: Hydraulic system

Pascal's Law

- Pascal's law states that:

  "a change in the pressure of an enclosed incompressible fluid is conveyed undiminished to every part of the fluid and to the surfaces of its container."
  - Force determined by pressure
  - Speed determined by flow rate

4.4. *Advantages and disadvantages of Hydraulics control systems*

- Advantage:
  - ✓ Able to generate extremely large forces from compact actuators
  - ✓ Easy to control speed
  - ✓ Easy to implement linear motion
- Disadvantage:
  - ✓ Large infrastructure (high-pressure pump, tank, distribution lines)
  - ✓ Potential fluid leaks
  - ✓ Noisy operation

- ✓ Vibration
- ✓ Maintenance requirements, expensive
- ✓ Characteristics of working fluids change with temperature and moisture

4.5. *Energy Flow Diagram* of *control systems*

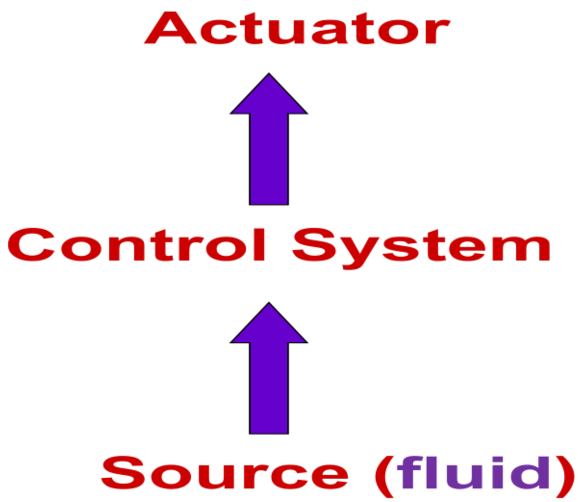


Figure 2: Energy Flow in hydraulic system

Hydraulic system Control

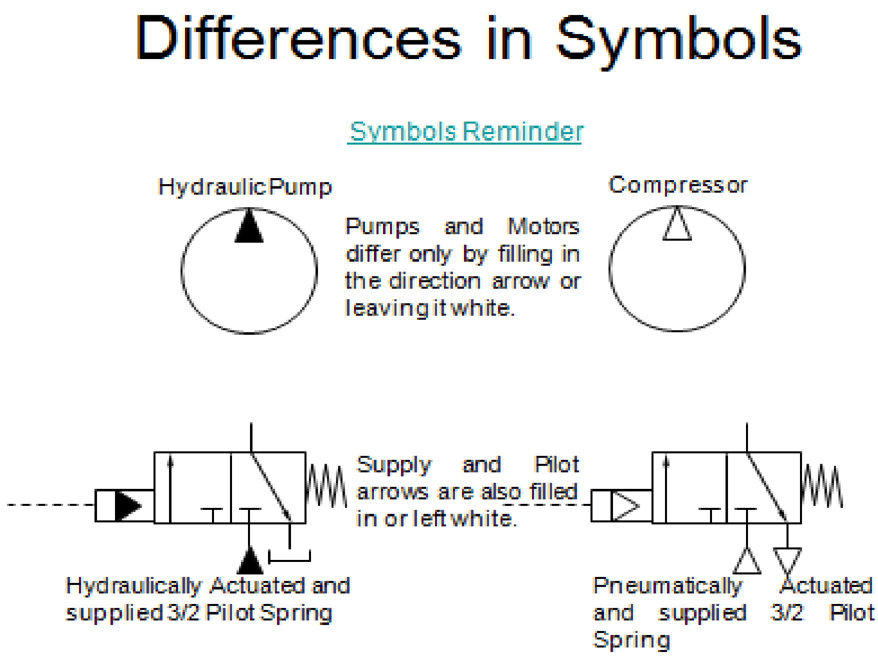
- ➢ Is Infinitely Controllable
- ➢ Produces Extremely Large Forces
- ➢ Requires High Pressures
- ➢ Requires Heavy Duty Components

Hydraulic Dangers

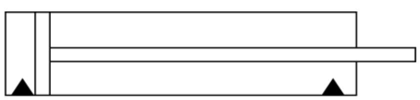
The dangers of working with high pressure oil can be infinitely more drastic:

- ➢ High Pressure Oil Injection
- ➢ Oil Burns
- ➢ Crushing/Cutting
- ➢ Carcinogens

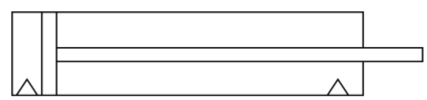
Differences in Symbols



Cylinders and other actuators also differ with respect to supply and direction arrows

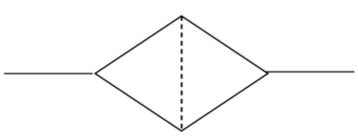


Hydraulic Double Acting Cylinder

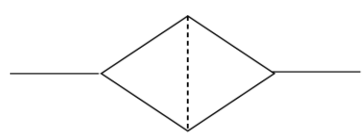


Pneumatic Double Acting Cylinder

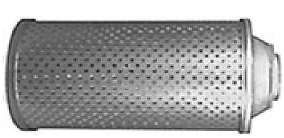
Many symbols do not change, for example the **Filter** symbol.



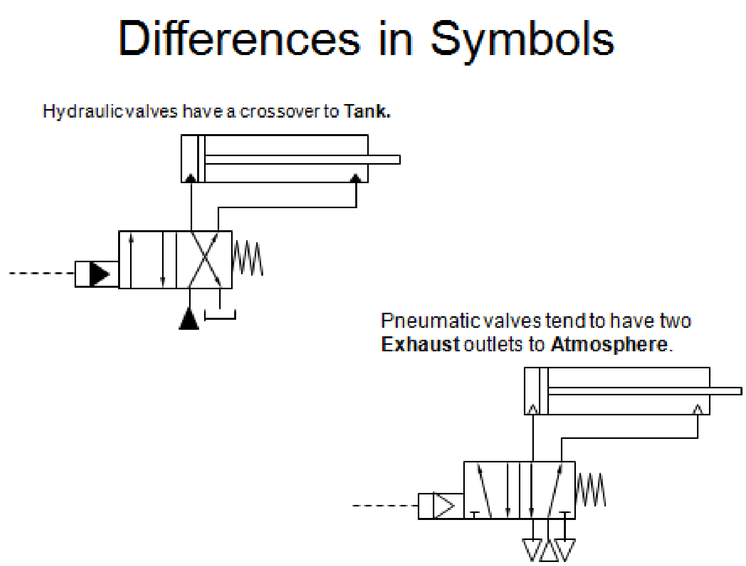
Hydraulic Filter



Pneumatic Filter



Remember however that the physical construction is completely different. For example, hydraulic filters can be Suction **Strainers** (suction side of the pump), **Pressure Filter** (pressure side of the pump) or **Return Filter** (in the return to tank line). Each filter requires different properties.



Differences in Medium

Hydraulic Oil is **Hygroscopic** and can be easily **oxidised** at high temperatures

Hydraulic Fluid is **viscous** and can be various types with varying **Viscosities** including:

- Flame Retardant
- Mineral Oil
- Synthetic Oil
- Water Glycol

Hydraulic fluid can have many additives including:

- Anti Oxidants
- Lubricity Improvement
- Anti Foaming Additive
- Anti Wear Additives

Lubrication

Hydraulic systems rely on a supply of **incompressible** fluid flowing through **Hoses** to **Actuators.**

The **Force** for work is produced due to the **Pressure** of the **Oil** acting on the **Area** of the actuator.

Oil is considered **Incompressible.**

Bernoulli's and other **Fluid Flow** Laws govern **medium** behaviour

Actuator demand is measured **litres per minute** for a specific speed

Pump output is measured **litres per minute**

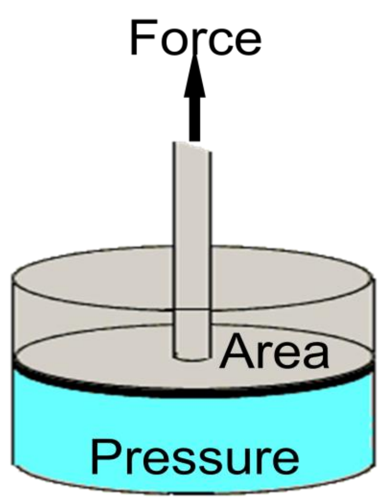
Both Hydraulics and Pneumatics are described with **Pascal's Law** and **F=PA**

Differences in Pressure and Force

Hydraulic Pressures and Forces

- Produced and used at 200~400Bar
- Forces up to Thousands of tonnes

Force Calculator



Information Sheet-2	Identifying Hydraulic system components

2.1. Basic Hydraulic system components

1. **Power input device:**
   - ✓ The pump and motor together are called the power input device; the pump provides power to the hydraulic system by pumping oil from the reservoir/tank.
2. **Control device:**
   - ✓ Valves control the direction, pressure, and flow of the hydraulic fluid from the pump to the actuator/cylinder.
3. **Power output device:**
   - ✓ The hydraulic power is converted to mechanical power inside the power output device.
   - ✓ The output device can be either a *cylinder which produces linear motion* or a *motor* which *produces rotary motion.*
4. **Source:** medium used in hydraulic systems to transmit power. Hydraulic fluid (Oil or water)
5. **Conductors:**
   - ✓ The conductors are the pipes or hoses needed to transmit the oil between the hydraulic components
6. **Hydraulic Motor :**
   - ✓ Receives power from moving fluid to transfer hydraulic power to mechanical rotating force.
7. **Cylinder:**
   - ✓ transfers hydraulic power into mechanical movement in one or two directions only
   - ✓ Single-acting- works in one direction only.
   - ✓ Double-acting- pushes and pulls.
8. **Shaft:** round bar that is extended from and retracted into a hydraulic cylinder.
9. **Seal:** Found in hydraulic components; function is to keep fluid from leaking between moving and non-moving parts

10. **Check Valve:** Restricts flow of fluid to only one direction; allows pressure to build up or be maintained.
11. **Spool Valve:** Controls direction of flow of fluid in a hydraulic /pneumatic system to cause the different parts of the system to function.

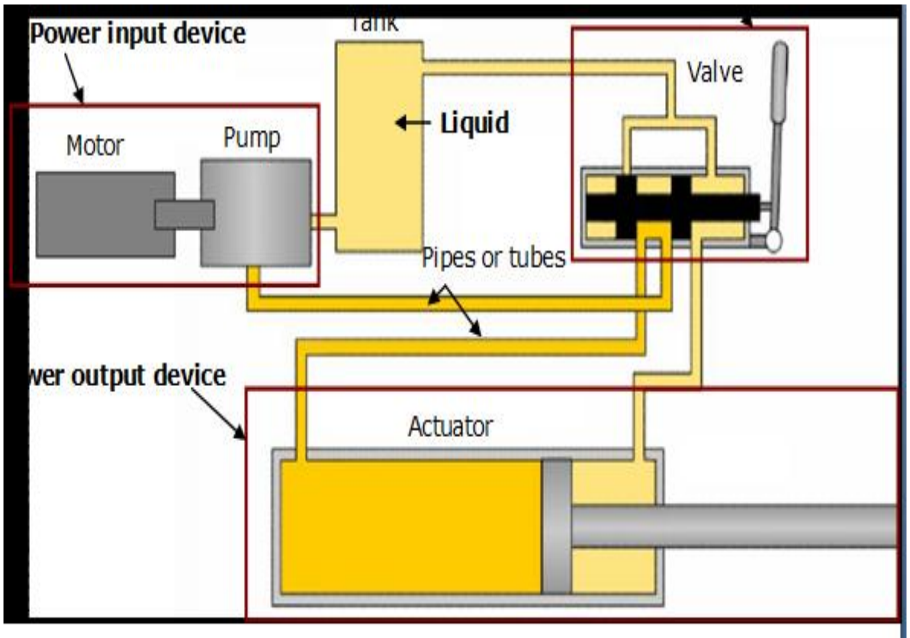
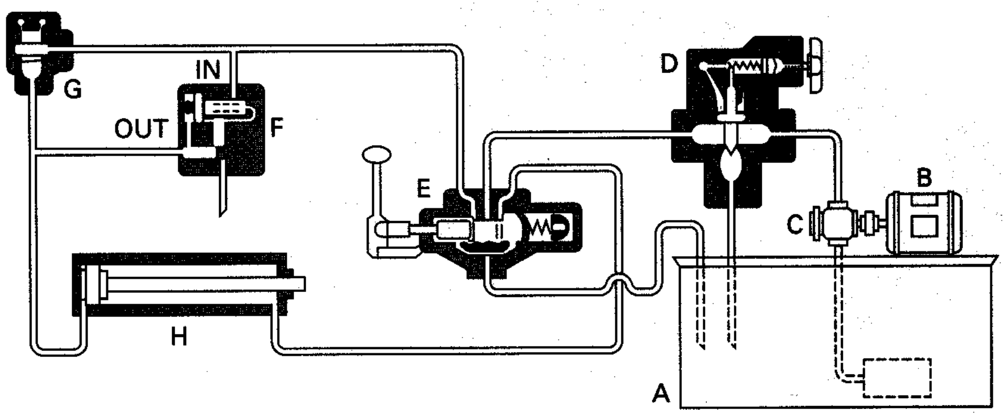


Figure 1: hydraulic system components

The above basic components can be summarized as

1. Reservoir
2. Pump
3. Electric Motor (prime mover)
4. Valves
5. Conductors (pipe, tubing, and hose)
6. Actuators



List of Components

A—Reservoir
B—Electric Motor
C—Pump
D—Maximun Pressure
(Relief) Valve
E—Directional Valve
F—Flow Control Valve
G—Right-Angle
Check Valve
H—Cylinder

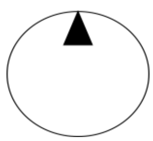
Figure 2: hydraulic system components (Summary)

Information Sheet-3	Distinguishing ISO Symbols of hydraulic system

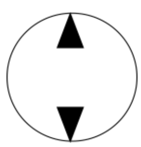
3.1. ISO Symbols of Hydraulic system components

Three Types of Pump

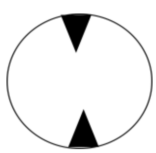
Circles/Semi-Circles



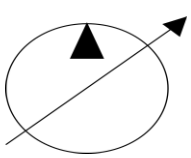
Unidirectional Fixed Displacement Hydraulic Pump



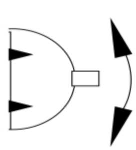
Bi-directional Fixed Displacement Hydraulic Pump



Bi-directional Fixed Displacement Hydraulic Motor



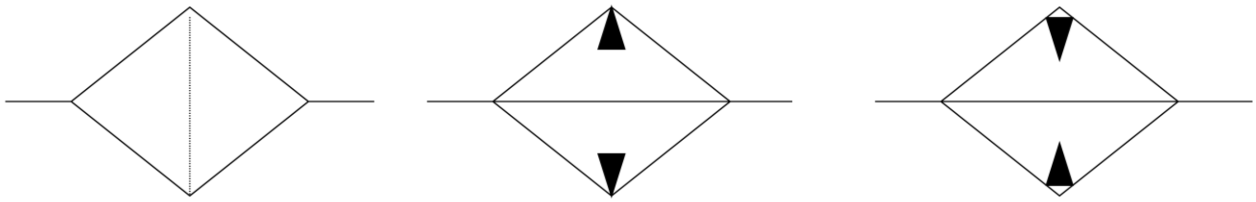
Unidirectional Variable Displacement Hydraulic Pump



Semi Rotary Actuator

Diamonds

Symbols in diamonds condition the oil in some way. filtering, Heating, cooling, etc.



Hydraulic Power Pack and Symbols

The power pack produces the flow of oil (and consequently the pressure) for the hydraulic system

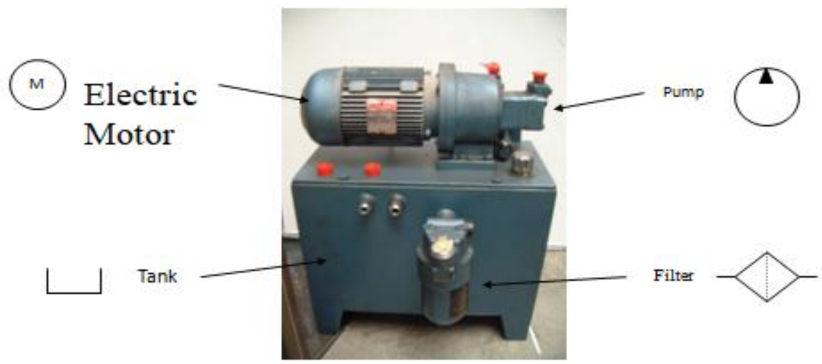
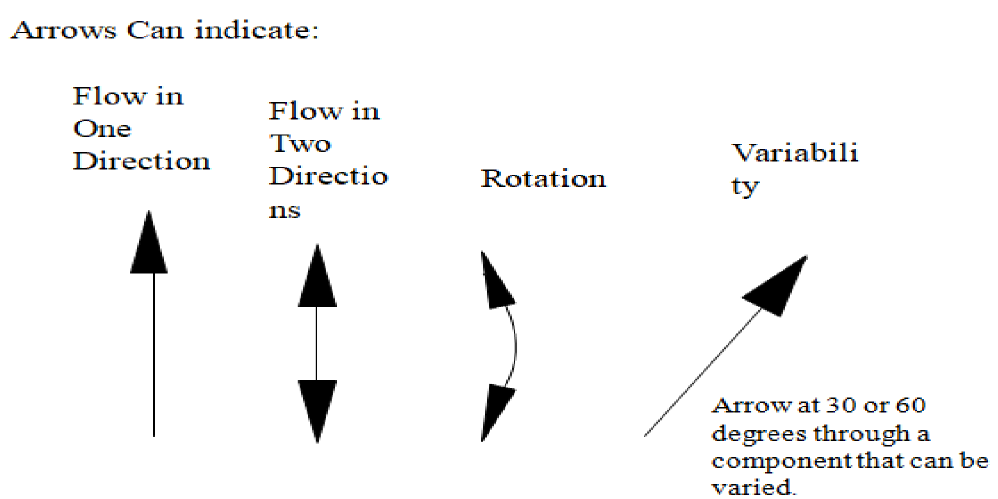


Figure3: hydraulic power pack

Direction Arrows



4.1. Hydraulic system circuit diagram (Schematic Symbols)

- A simple hydraulic power transmission from one point to another is shown in figure below:

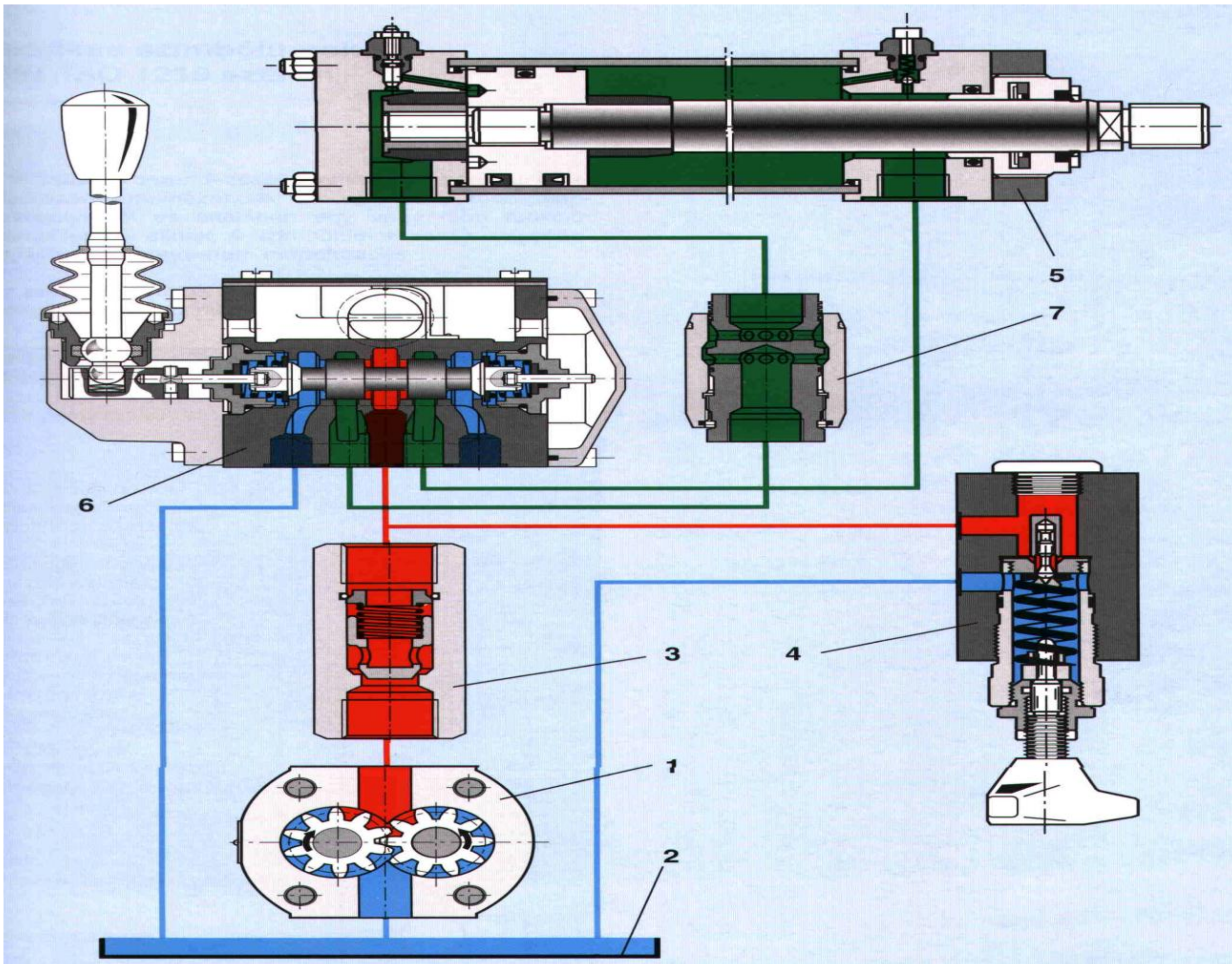


Figure 4: Simple hydraulic system diagram

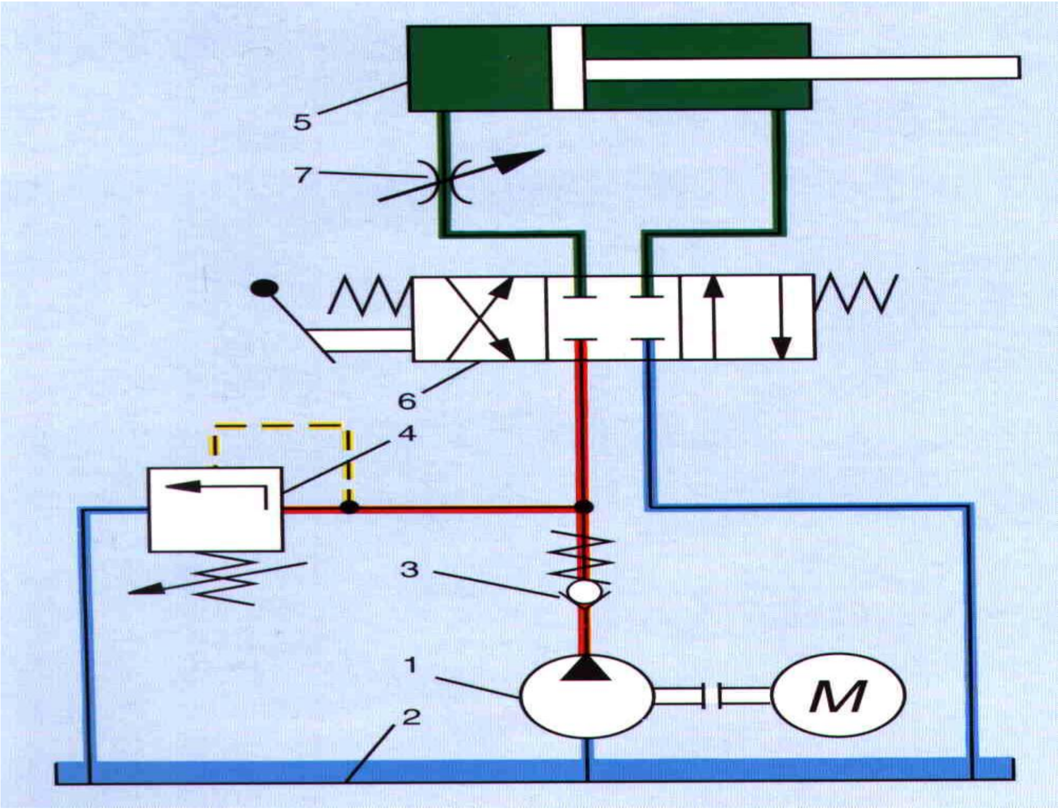


Figure 5: Simple hydraulic circuit system

Key:

1 – Pump

2 – Oil tank

3 – Flow control valve

4 – Pressure relief valve

5 – Hydraulic cylinder

6 – Directional control valve

7 – Throttle valve

Self-Check -1	Check out Test

Test I: Open ended questions

Directions: **Questions to Ask Yourself** **(each question have 3.pts)**

1. What are the two types of fluid power systems?
2. How is energy transmitted in a fluid power system?
3. Name the most common form of energy generated (used) by power plants. Why?
4. What does a hydraulic system do? (*What is its purpose*?)
5. Name two advantages a hydraulic system has when compared to a pneumatic system.

Satisfactory- above 10 points **Unsatisfactory - below 10 points**

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

1.

Answer Sheet

Score = ___________
Rating: ____________

Name: _________________________ Date: _______________

Self-Check -2	Check out Test

Test II: Open ended questions

Directions: **Questions to Ask Yourself** **(each question have 4.pts)**

1. Name six advantages a hydraulic system has when compared to a pneumatic system.

2. Which method or methods of control would you consider best for the following machine applications? *(Hydraulic, Pneumatic, Electric)*

   A. Machine Press generating ______________

   B. 40,000 RPM drill used in dentist's ______________

   C. Constant speed conveyor. ______________

D. Operating airplane steering. ______________

3. Name two kinds of hydraulic actuators and describe the type of motion each produces.

Satisfactory- above 7 points **Unsatisfactory - below 7 points**

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

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Self-Check -3	Check out **Test**

Test III: Open ended questions

Directions: **Questions to Ask Yourself** **(each question have 4.pts)**

1. What type of device is most often used in an industrial application to drive the pump of a hydraulic system?

2. Maximum fluid pressure is one of three quantities controlled in a hydraulic system. A relief valve is used to do this. Name two other quantities that are controlled in a hydraulic system and the device that controls each.

3. What do you think would happen to the hydraulic system if the cylinder or motor encountered a load it could not move? Would this be harmful?

Satisfactory- above 8 points **Unsatisfactory - below 8 points**

1.

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

Answer Sheet

Score = ____________

Rating: _____________

Name: ___________________________ Date: ________________

MECHANICS

LEVEL-III

Learning Guide-#56

Unit of Competence: Install and Maintain Basic Pneumatic and Hydraulic Systems

Module Title: Install and Maintain Basic Pneumatic and Hydraulic Systems

Module Code: XXX

LG Code: XXXXX

TTLM Code: XXXXX

LO5: Install hydraulic system Components

Instruction Sheet	Learning Guide #56

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

- Installing hydraulic pumps
- Installing pump accessories and fittings
- Installing hydraulic system controlling elements
- Installing liquid transmission elements (cables)
- Installing hydraulic actuating elements

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

- Install hydraulic pumps
- Install pump accessories and fittings
- Install hydraulic system controlling elements
- Install liquid transmission elements (hoses)
- Install hydraulic actuators

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described from 3 to 6
3. Read the information written in the information "Sheet 1
4. Accomplish the "Self-check 1, and Self-check 2" **in page -72** and 73 respectively
5. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet 1" **in page -74.**
6. Do the "**LAB** test" in operation sheet1 in **page – 74** (if you are ready).

Information Sheet-1	Installing hydraulic system components

5.1.Introduction

The primary components of the hydraulic system include the following:

1. **Reservoir**.
2. **Filters**.
3. Shut Off **Valves**.
4. Control **Valves**.
5. Pressure Relief **Valve**.
6. Hydraulic Fuses.
7. Accumulators.

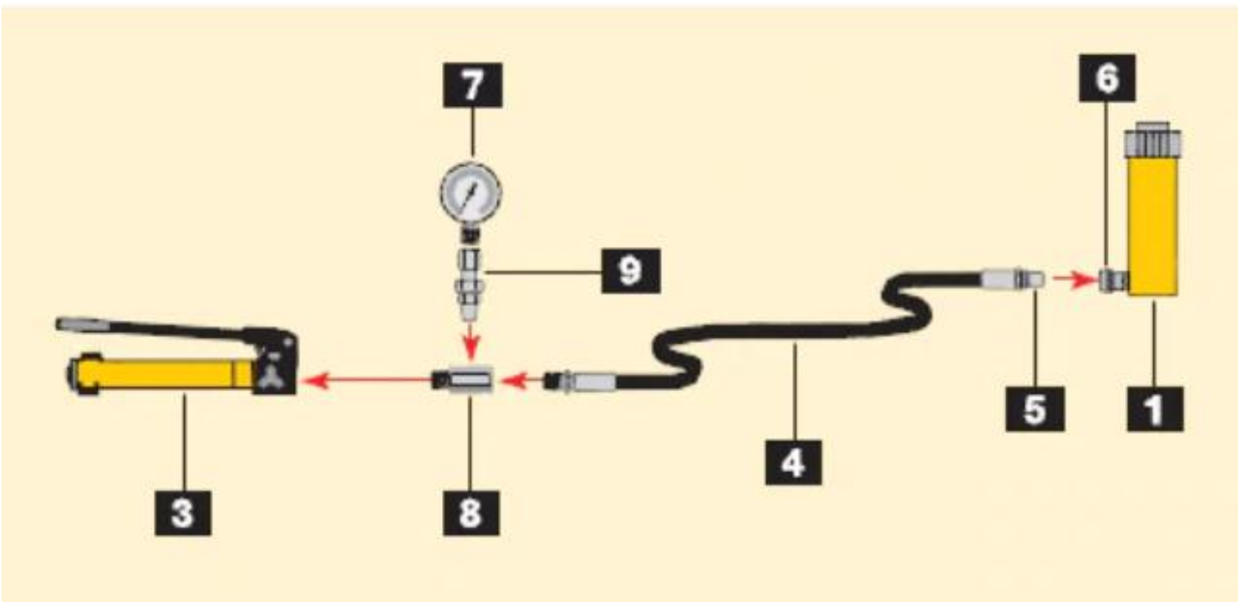
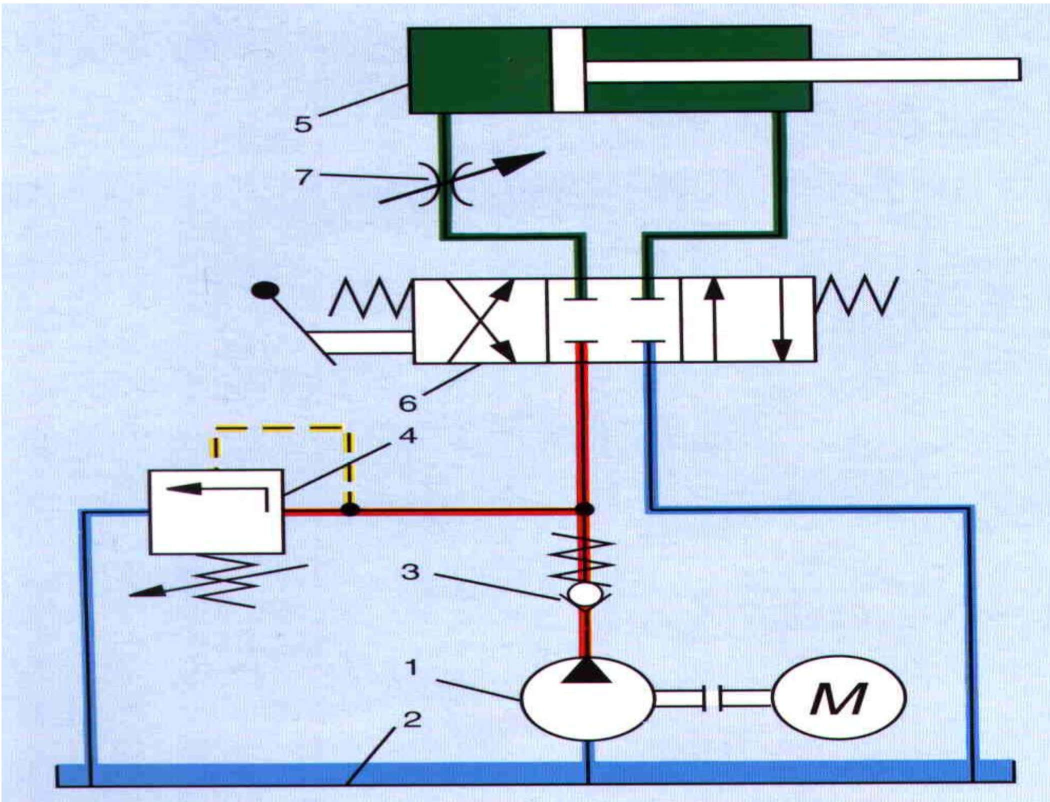


Figure7: simple hydraulic system installation

Self-Check -1	Practical work

Test I: Lab test

Directions: install the following hydraulic system (10.pts)



Satisfactory- above 7 points **Unsatisfactory - below 7 points**

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

Answer Sheet

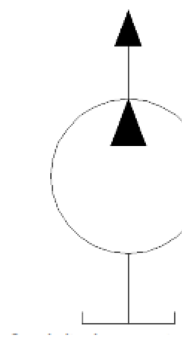
Score = ___________
Rating: ____________

Name: ____________________________ Date: _________________

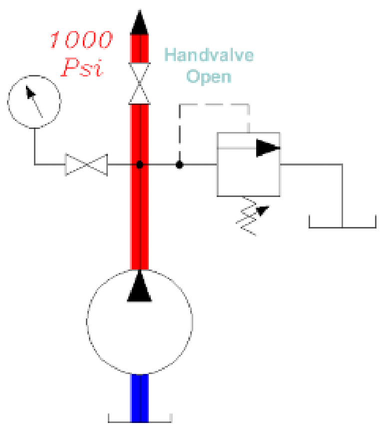
Operation sheet -1	Hydraulic system operation

Hydraulic system operation

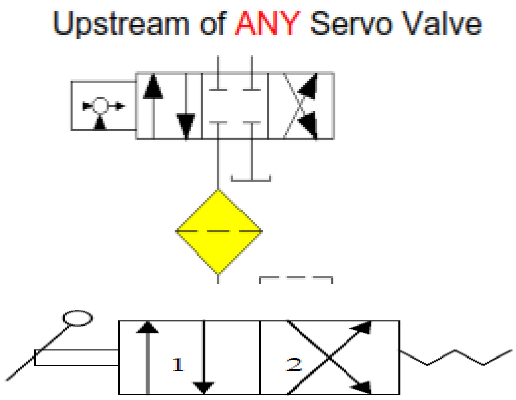
Step 1: Place the right fluid pump and tank connections at the designed/appropriate position



Step 2: Setting the relief valve in a fixed displacement pump circuit



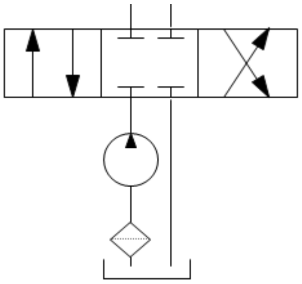
Step 3: Place an appropriate directional control element (Valve) at the right position (Setting the pressure line filter and directional control valve and actuation method)



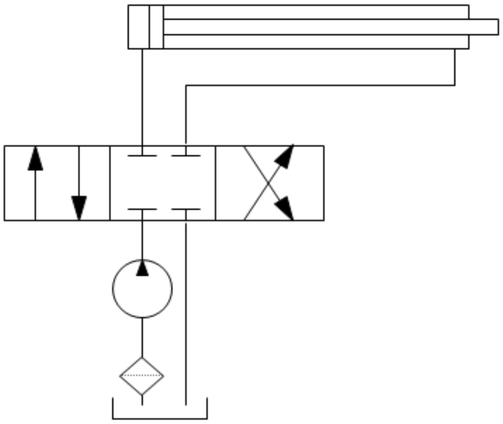
Step 3: Place the hydraulic actuator, i.e. hydraulic cylinder, at the design position of the

output

Step 4: Connect the pump outlet port with the directional control valve inlet port by the hydraulic hose



Step 5: Connect all the directional control valve working ports with the hydraulic actuator (linear or rotary and single or double) by the pneumatic hoses



Step 6 (optional): Control the pressure of the system using the pressure control valves

Step 7 (optional): Control the speed of the actuators using the flow control valves

MECHANICS

LEVEL-III

Learning Guide-#57

Unit of Competence: Install and Maintain Basic

Pneumatic and Hydraulic Systems

Module Title: Install and Maintain Basic Pneumatic and Hydraulic Systems

Module Code: XXX

LG Code: XXXXX

TTLM Code: XXXXX

LO6: Maintain hydraulic system Components

Instruction Sheet	Learning Guide #57

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

- Introducing to hydraulic system Maintenance
- Maintaining pump accessories and fittings
- Maintaining hydraulic system controlling elements
- Maintaining liquid transmission elements (cables)
- Maintaining hydraulic actuating elements

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

- Install hydraulic pumps
- Maintain pump accessories and fittings
- Maintain hydraulic system controlling elements
- Maintain liquid transmission elements (hoses)
- Maintain hydraulic actuators

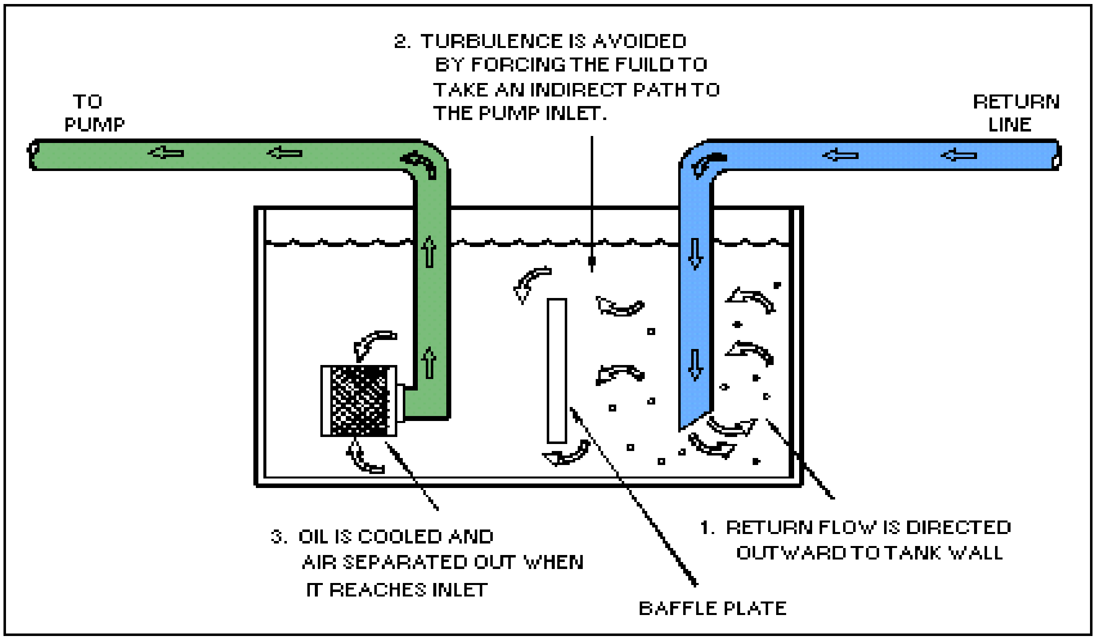
Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described from 1 to 3
3. Read the information written in the information "Sheet 1
4. Accomplish the "Self-check 1" **in page -97**

Information Sheet-1	Introducing to hydraulic system Maintenance

a. Maintenance of Hydraulic Systems

Hydraulic systems have many benefits, but leaks and plenty of maintenance requirements stop many businesses from using them for their applications. Luckily, proper hydraulic maintenance can prevent most of your problems, including leaks, as well as maximize hydraulic system uptime. After all, hydraulic maintenance requirements are not that complicated if you have a detailed preventive maintenance program on hand. In this article, learn about hydraulic fluid maintenance, preventive maintenance task lists, and how to measure the success of your hydraulic maintenance program.



Lack of maintenance of hydraulic systems is the leading cause of component and system failure yet most maintenance personnel don't understand proper maintenance techniques of a hydraulic system. The basic foundation to perform proper maintenance on a hydraulic system has two areas of concern. The first area is Preventive Maintenance which is key to the success of any maintenance program whether in hydraulics or any equipment which we need reliability. The second area is corrective maintenance, which in many cases can cause additional hydraulic component failure when it is not performed to standard.

i. Three Types of Hydraulic Maintenance

There are three main types of hydraulic maintenance: **reactive maintenance (RM)**, **preventive maintenance (PM)** and **predictive maintenance (PdM)**.

Reactive maintenance stands for breakdown maintenance and involves the repairs that are done to fix the equipment that is already broken.

Predictive Maintenance or condition-based maintenance uses sensor devices to collect information about the system and components and prompts the personnel to perform maintenance at the exact moment when it’s needed. Due to high costs and technical requirements, it is still new to the market and not used very often.

Preventive maintenance is regular maintenance that is performed on the equipment to prevent it from breaking down. Preventive Maintenance is implemented through a Preventive Maintenance Program. The Preventive Maintenance Program is defined by the operating conditions and manufacturer requirements for each individual component and for the system as a whole. To start, you should write down or update the procedures for each preventive maintenance tasks. We recommend having a written copy of the Preventive Maintenance Program even if you own a small business and do not have a maintenance technician on staff. It is vital that all maintenance employees know, understand, and follow the maintenance procedures explicitly created for your business.

ii. Hydraulic Fluid Maintenance Best Practices

Since the hydraulic system uses hydraulic fluid to power hydraulic machinery, you should pay extra attention to hydraulic fluid maintenance and care. Hydraulic fluid performs many functions, including minimizing wear and tear, reducing friction, removing heat, protecting the system from rust and deposits, removing debris, and dirt from the system.

The most common problems that cause hydraulic fluid going bad are system overheating, system contamination, and dirty operating environment. Therefore, to take care of the hydraulic fluid, you should take the following actions:

1. **Prevent the hydraulic system from overheating.** Hydraulic fluid gets hot while being pushed through the pumps, tubing, and relief valves. If the system's temperature is too low, the condensation starts in the reservoir, which can cause pump cavitation. On the contrary, if the temperature is too high, oxidation that causes varnish and sludge deposits occurs. Most hydraulic systems run in the 110-150°F range with mobile hydraulic systems running up to 250°F. If you use a water-based hydraulic fluid, don't let the temperature go below 140°F, so the water does not evaporate from the fluid. Perform regular checks of the oil cooler and outside the reservoir to prevent overheating.
2. **Keep the System Clean.** Prevent contamination of the system by dirt, water, metal debris from entering the system by keeping the reservoir cover, drain lines, and breather fill openings always clean.
3. **Keep the Fluid Clean. Test oil regularly for contaminants.** Store hydraulic fluid in the designated containers in the clean environment; clean the fill cap before adding hydraulic fluid. Change and check fluid filters on a regular basis. Filter oil added to the system through portable filters to achieve better results

Hydraulic Preventive Maintenance Task List

As a general recommendation technician or equipment operator shall perform a weekly scan of the equipment to make sure it's functioning properly.

The typical weekly Preventive Maintenance list should include, but is not limited to the following tasks:

1. Check hydraulic fluid levels. Add hydraulic fluid of the same brand and viscosity grade if needed using portable filters when applicable.
2. Check breather caps, filters, and fill screens.
3. Check return/pressure/hydraulic filter indicators and pressure gauges for readings.
4. Sample hydraulic fluid for color, visible signs of contamination, and odor.

5. Check system temperature using a built-in or spot infrared thermometer. If the temperature is higher than recommended by the manufacturer, check the condition of the cooler and relief valve settings.
6. Inspect inside of the hydraulic reservoir for any signs of aeration. Use a flashlight and look into the fill hose for any signs of foaming or small whirlpools. Aeration may be a sign of a leak in the suction line or faulty shaft seals, so it's important to inspect the reservoir on a regular basis.
7. Inspect hydraulic hoses, tubing, and fittings for leaks and frays. Remember that any leakage is an environmental and safety hazard since hydraulic fluid gets hot inside the system and is highly toxic. If the fluid level gets too low, the system will operate at reduced capacity and will get overheated.
8. Inspect proportional/servo valves for overheating. High temperature means that the valve is sticking.
9. Listen to the pump for making any unusual noise. The noise may be a sign of **cavitation. Cavitation** is the formation of bubbles or so-called cavities in the hydraulic fluid and is caused by the air that gathers in the areas of relatively low pressure around an impeller. It damages the pump, decreases the flow, and causes vibration if not treated.
10. Scan the electric drive motor with a handheld infrared thermometer for hot spots.

Preventive Maintenance of a hydraulic system is very basic and simple and if followed properly can eliminate most hydraulic component failure. Preventive Maintenance is a discipline and must be followed as such in order to obtain results. We must view a PM program as a performance oriented and not activity oriented. Many organizations have good PM procedures but do not require maintenance personnel to follow them or hold them accountable for the proper execution of these procedures. In order to develop a preventive maintenance program for your system you must follow these steps:

1st: Identify the system operating condition.
a. Does the system operate 24 hours a day, 7 days a week?

b. Does the system operate at maximum flow and pressure 70% or better during operation?

c. Is the system located in a dirty or hot environment?

2nd: What requirements does the Equipment Manufacturer state for Preventive Maintenance on the hydraulic system?

3rd: What requirements and operating parameters does the component manufacturer state concerning the hydraulic fluid ISO particulate?

4th: What requirements and operating parameters does the filter company state concerning their filters ability to meet this requirement?

5th: What equipment history is available to verify the above procedures for the hydraulic system?

As in all Preventive Maintenance Programs we must write procedures required for each PM Task. Steps or procedures must be written for each task and they must be accurate and understandable by all maintenance personnel from entry level to master.

Preventive Maintenance procedures must be a part of the PM Job Plan which includes:

- Tools or special equipment required performing the task.
- Parts or material required performing the procedure with store room number.
- Safety precautions for this procedure.
- Environmental concerns or potential hazards.

A list of Preventive Maintenance Task for a Hydraulic System could be:

1. Change the (could be the return or pressure filter) hydraulic filter.
2. Obtain a hydraulic fluid sample.
3. Filter hydraulic fluid.
4. Check hydraulic actuators.
5. Clean the inside of a hydraulic reservoir.

6. Clean the outside of a hydraulic reservoir.
7. Check and record hydraulic pressures.
8. Check and record pump flow.
9. Check hydraulic hoses, tubing and fittings.
10. Check and record voltage reading to proportional or servo valves.
11. Check and record vacuum on the suction side of the pump.
12. Check and record amperage on the main pump motor.
13. Check machine cycle time and record.

Preventive Maintenance is the core support that a hydraulic system must have in order to maximize component and life and reduce system failure. Preventive Maintenance procedures that are properly written and followed properly will allow equipment to operate to its full potential and life cycle. Preventive Maintenance allows a maintenance department to control a hydraulic system rather than the system controlling the maintenance department. We must control a hydraulic system by telling it when we will perform maintenance on it and how much money we will spend on the maintenance for the system. Most companies allow the hydraulic system to control the maintenance on them, at a much higher cost.

In order to validate your preventive maintenance procedures you must have a good understanding and knowledge of "Best Maintenance Practices" for hydraulic systems. We will convey these practices to you.

Component	Component Knowledge	Best Practices	Frequency
Hydraulic Fluid Filter	There are two types of filters on a hydraulic system. 1.) Pressure Filter - Pressure filters come in collapsible and non-collapsible types. **Preferred filter** is the non-collapsible type. 2.) Return Filter - Typically has a bypass, which will allow contaminated oil to bypass the filter before indicating the filter needs to be changed.	1. Clean the filter cover or housing with a cleaning agent and clean rags. 2. Remove the old filter with clean hands and install new filter into the filter housing or screw into place. CAUTION: NEVER allow your hand to touch a filter cartridge. Open the plastic bag and insert the filter without touching the filter with your hand.	**Preferred**: based on historical trending of oil samples. **Least Preferred**: Based on equipment manufacture's recommendations.
Reservoir Air Breather	The typical screen breather should not be used in a contaminated environment. A filtered air breather with a rating of 10 micron is preferred because of the introduction of contaminants to a hydraulic system.	1. Remove and throw away the filter.	Preferred: Based on historical trending of oil samples. **Least Preferred**: Based on equipment manufacture's recommendations
Hydraulic Reservoir	A reservoir are used to: 1. Remove contamination. 2. Dissipate heat from the fluid. 3. Store a volume of oil.	1. Clean the outside of the reservoir to include the area under and around the reservoir. 2. Remove the oil by a filter pump into a clean container, which has not had other types of fluid in it before. 3. Clean the insides of the reservoir by opening the reservoir and cleaning the reservoir with a "Lint Free" rag. 4. Afterwards spray clean hydraulic fluid into the reservoir and drain out of the system.	If any of the following conditions are met. 1. A hydraulic pump fails. 2. If the system has been opened for major work. 3. If an oil analysis states excessive contamination
Hydraulic Pumps	A maintenance person needs to know the type of pump they have in the system and determine how it operates in their system. Example: What is the flow and pressure of the pump during a given operating cycle. This information allows a maintenance person to trend potential pump failure and troubleshoots a system problem quickly.	1. Check and record flow and pressure during specific operating cycles. 2. Review graphs of pressure and flow. 3. Check for excessive fluctuation of the hydraulic system. (designate the fluctuation allowed)	**Pressure checks:** Preferred - Daily Least Preferred: Weekly Flow & Pressure checks: Preferred- Two weeks Least preferred: Monthly

b. Maintaining hydraulic system Elements

Hydraulic systems are not as complicated as you might think. Through regular maintenance you will become familiar with the components and be able to diagnose potential problems.

The components of hydraulic systems work together intimately. As a result, damage to one component may cause further damage to others. For instance, overheated oil caused by a leaky cylinder seal can break down and cause damage to other cylinders or the pump. That's why it pays to perform regular maintenance and preventative inspections to eliminate problems before they occur.

Most hydraulic systems consist of a pump, hoses and lines, cylinders and motors, valves, a cooling unit, a reservoir, filters and hydraulic fluid (oil). At the heart of the system is the pump. It uses energy from the engine to pump the fluid and create hydraulic flow and pressure. Valves control the flow of the fluid by restricting or redirecting it. Cylinders and motors are the muscles of hydraulic systems. Cylinders have a straight, push-pull action while motors use the energy from the fluid to turn a shaft. The speed at which these components operate is determined by the hydraulic-oil flow rate, while the hydraulic pressure determines the force they exert. The cooling unit acts to cool the fluid after it has gone through the system and the reservoir feeds the pump. Connecting all of these components are hoses, line and fittings.

A fluid ounce of prevention

The basic prescription for hydraulic maintenance is prevention. If you keep contaminants out of hydraulic systems, you will avoid nearly all common problems and failures. However, some contaminants inevitably do enter the system and scratch close-fitting surfaces in the components. Therefore, follow these guidelines to keep your hydraulic fluid in top condition.

- **Keep contaminants out of your hydraulic system.** Clean the area around dipsticks, fill plugs and hydraulic filters before removing them to check or change the hydraulic fluid. Keep all fluid containers tightly sealed when stored and pour directly from the container into the system.
- **Change the fluid and filter after the initial 50 hours of use.** Often, the manufacturing process allows contaminants to enter the hydraulic system. A fluid change after 50 hours will eliminate these particles. Thereafter, change hydraulic fluid and filters at regular intervals as recommended in the owner′s manual.
- **Check oil before each use.** Verify that fluid levels are adequate and that the fluid is in good condition. An inadequate amount of oil can cause severe damage to pumps. If your oil appears foamy or milky, you may have a leak that is causing air to enter the system. Air will cause jerky and slow operation of the hydraulics. Locate and seal the source of any leak.

Also, air within the system holds moisture. When the system cools down after operation, the moisture can condense and mix with the hydraulic fluid. Water in the hydraulic fluid looks similar to the milky appearance resulting from air contamination. To confirm that it's water, pour 1/8 cup of hydraulic fluid into a metal can and heat it with a propane torch. If you hear popping or crackling, then the fluid has water in it and you should change it immediately.

- **Regularly check the temperature of the hydraulic fluid during operation.** Is the fluid too hot to touch? Does it smell burnt? Your cooling system may be not working properly or you may have pressure-related problems. Check the hydraulic oil cooler or reservoir. They must be kept clean. Remove any dirt or other debris that inhibits airflow around them. If the fluid remains hot for extended periods, it can break down and lose its ability to lubricate adequately.

i. Maintaining pump

Aside from inspecting the pump for any obvious external wear and damage, you should listen for cavitation. It results when the pump does not receive the proper amount of fluid from the reservoir. Follow these steps every 50 hours or so to check for cavitation.

1. Listen to the pump when the hydraulics are operating. If it rattles or sounds like it is full of marbles or rocks, then cavitation is occurring and the system should be shut down immediately.
2. Check the fluid level and filter to determine if they could be limiting or restricting flow.
3. Next, determine if any previous modifications have been made to the reservoir, inlet lines or pump. If any of the components are altered, the pump inlet flow may be affected.
4. Check inlet lines for any leaks, bends, pinching or other discontinuities that may restrict flow. Also, many systems have inlet strainers that act as a second filter to keep damaging contaminants from reaching the pump. If your system has a strainer, regularly clean it to maintain the needed inlet flow.

Most important, maintain clean fluid and filters. Pumps have check valves, vanes, pistons and gears that can be scoured and damaged by contaminants. This will result in inefficient pumping and cause wear on other parts of the equipment.

ii. Maintaining hydraulic system controlling elements

Valves

Valves consist of tight-fitting components that block or direct flow. These can be abraded and leak (internally), resulting in low hydraulic pressure. Contaminants can lodge in valves and restrict flow. Again, maintain clean hydraulic fluid to keep valves in good working order.

iii. Maintaining liquid transmission elements (cables)

The next aspect of routine maintenance is checking the hoses, lines, fittings and couplers. Inspect these components to determine if they have been damaged and ensure they are in good condition and in the right location.

- **Inspect hoses and lines.** Metal lines may be dented from falling tools, contact with other equipment or myriad other reasons. Inspect lines for cracking, cuts or dents that restrict flow or cause pressure leaks. Hoses can be damaged in the same manner, as well as from overheating, extended wear and defective manufacturing. Look for crimped or collapsed hoses that could be restricting flow. The hose could be internally damaged, causing pieces of the hose to enter the hydraulic system and contaminate it.
- **Check the hose routing.** Sometimes brackets break and hoses and lines end up where they are not supposed to be. They can be pinched, kinked, overstretched or chafed.
- **Inspect hoses at flex points.** Operate the hydraulic system and observe the flex point for kinking or stretching.
- **Check all fittings on hoses to make sure they are snug.** If you notice leakage at a fitting, tighten it. Be careful to not overtighten or thread damage will result.
- **Check couplings.** Always keep these points clean, they are a major source of contamination. Make sure that caps are in place when the couplings are not used and replace any caps that do not fit tightly. Before connecting any lines, thoroughly clean each coupling.
- **Keep the hoses clean by washing machinery on a regular basis.** This will also help to reduce hydraulic fluid temperatures.

If a hose or line is damaged, make sure that any replacements are of the same length, size and wall thickness. Refer to the service manual for specifications.

iv. Maintaining hydraulic actuating elements

Cylinders and motors

- Cylinders have seals and rings that can be damaged by excess pressure and contaminants in the fluid. Once again, be sure that your hydraulic fluid is clean. Check the points where the cylinder rod moves in and out of the cylinder housing for leaks. Check the length of the cylinder rods for any dings, dents or other damages that could allow fluid and pressure to escape.

A cylinder is designed to take loads along its axis only. Side loads can decrease cylinder life by causing excess wear on seals and the rod.

- With hydraulic motors, as with pumps, your primary maintenance consideration is clean hydraulic oil. The gears, vanes and pistons can be abraded by contaminants, resulting in pressure loss. Before each use, check the drive shaft of the motor for any damage or leakage. Be sure that motors are started and operated at the correct rpm. The owner′s manual will provide this information.

c. Regular preventative inspection

It is time-consuming to thoroughly check the hydraulic system before and after each use. However, most hydraulic systems are not checked until the operator complains of poor performance. By this time, it may be too late to prevent a major repair. Aside from regular maintenance described in the owner′s manual, follow these basic procedures every 50 hours or so to determine the health of your system and prevent costly failures. Once you have located a problem, contact a professional hydraulic technician to do most repair work. They can ensure that all of the specifications and tolerances within the system are maintained.

Inspecting for restricted flow

Slow hydraulics are the result of restricted flow. Low oil level, restricted hoses and lines, and damaged valves, pumps, cylinders and motors are all possible causes.

1. Activate the hydraulic system and determine which individual system components are operating slowly. If, for instance, the bucket on your skid-steer loader does not raise or lower at the normal speed, but other hydraulic attachments do, then the restriction is in the lines and components that service the bucket. Visually inspect these components for leaks. Pay particular attention to connecting points.
2. If no external restriction is obvious, then the obstruction may be internal. Large contaminants may be blocking a valve or have become lodged in part of a cylinder or motor.
3. If you cannot isolate the obstruction and the entire system is operating slowly, then check the pump. If you hear the sound of cavitation, then the pump is not getting enough flow. Determine that the fluid levels are adequate and the all filters and strainers are clean. If the problem persists, check the inlet line to make sure that there is no blockage or kinking. Also, verify that the pump shaft is operating and not damaged.

Inspecting for weak hydraulics

Weak hydraulic response is the result of low pressure. The system may be delivering the amount of flow desired, but due to pressure leaks, the system does not efficiently use the flow to perform work. Pressure problems can result from damaged pumps, worn valves and worn components in motors and cylinders. If, for example, your bucket does not lift as much weight as it should, then there is a leak in the path of flow that is allowing pressure to be lost. To check a bucket attachment, perform the following steps (or comparable steps for other components).

1. Raise the bucket to full height and shut off the engine. Remove pressure from the line by moving the control lever back and forth once or twice. Then look carefully to see if the bucket begins to creep downward. If it does, the leak could be in the cylinder, or a valve that controls flow to the bucket, or both.

2. Block the raised bucket and disconnect the hose that is not under pressure from the cylinder. Now, unblock the bucket. If you notice oil seeping from the port, the cylinder is leaking. If no leak is noticed at the cylinder, then a valve may be defective.
3. Do this to all attachment points on the hydraulic system. If you cannot pinpoint the leak to a specific location, then the pump or one of the primary valves may be leaking.
4. To verify that internal leaks are occurring, check the oil for excess heat. If internal leaks are present, oil is forced through small spaces where the leak is. This increases friction and causes the oil to heat up.

The first step in preventative maintenance is to become familiar with your hydraulic system. The key is to know where the oil flows and how each component functions. Study the layout and determine where the components are and how the hoses and lines are routed. Determine which valves service each cylinder and motor. Once you know your system, regular maintenance and preventative inspections will be easy.

d. Practice good hydraulic system maintenance

When it comes to hydraulic system maintenance, it is vital that the people involved in recording data, taking samples, using test equipment, etc., are properly trained in the jobs they have to perform and the equipment they have to use. No matter how comprehensive the maintenance procedures are, there will inevitably be occasions when maintenance personnel have to use their initiative, so it is important that they are properly equipped to do so.

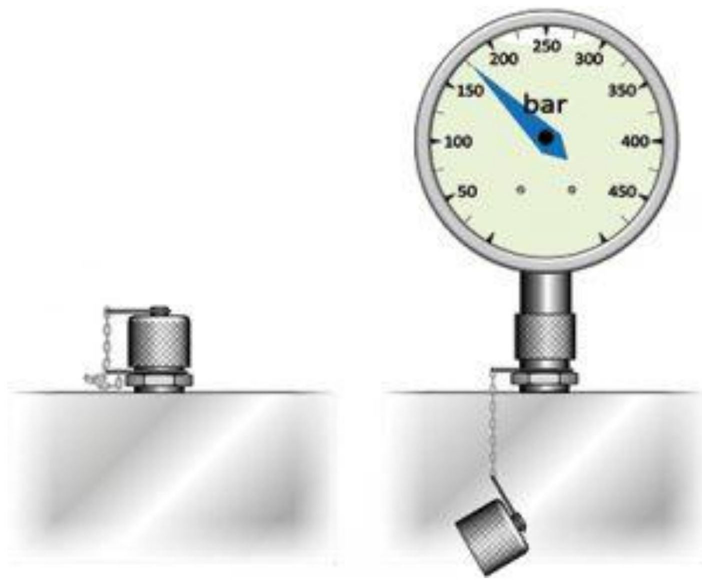


Figure 1. Pressure test point, above and below

Examples of good maintenance practice include the following:

Pressure test points. Fit pressure test points into the system where pressure readings are likely to be required (such as when setting pressure-relief or pressure-reducing valves). Gauges permanently connected into the system may be subject to pressure peaks and ripple, and so tend to have a short life. They can be protected by 'push to read' or 'twist to read' valves, which normally isolate them from the system, or they can be removed completely and only connected when required via simple quick-release test points (**see Figure 1**).

Access points. Include access points for taking fluid samples from the system, normally from the pressure line or from the reservoir. Sampling from the reservoir should ideally be via a pipe, taking fluid from the center of the reservoir, away from where water or contamination is likely to settle.

Flow meters. Flow meters are sometimes permanently connected into systems but more often need to be connected temporarily for test purposes. This process can be made simpler by including quick-release couplings and/or three-way valves to divert flow through the meter when required (Figure 2). Care should be taken, however, to ensure that the test equipment and associated fittings do not create undue restriction (e.g., in the case drain line of pumps and motors).

Adding new fluid. As stated previously, new fluid to be added to a reservoir will normally require cleaning, so provision should be made to incorporate a filter on the reservoir filling connection. If this is not practical, a filling point should be included so that it is not possible to simply pour fluid into the tank. If filling of the tank has to be carried out by pumping the fluid in (e.g., via a quick-release coupling or side connection), it is more likely to be done correctly via a fluid-transfer cart and filter.

Label reservoirs. Color code or clearly label each system reservoir with the correct fluid to be used for filling and topping up.

Mark normal fluid levels. Mark the normal maximum and minimum fluid levels on the reservoir sight glass.

Shut-off valves. Where shut-off valves are likely to cause damage if set incorrectly, for example on pump inlet or drain lines, they should be monitored via limit or proximity switches that are interlocked to ensure pumps cannot be started unless the valves are fully open.

Drain valves. Consider using automatic drain valves on accumulators to drain the pressurized fluid whenever the machine is switched off. Manual valves should also be included (as a back-up), together with an isolated pressure gauge to verify that the accumulators have been discharged.

Components requiring regular attention. Ensure components requiring regular attention (filters, test points, gauges, etc.) are easily accessible, and that spillage trays are placed where fluid is likely to be spilled during maintenance activities (e.g., changing filter elements).

Flush valves. Consider adding flushing valves around actuators (Figure 3). This will make the flushing process simpler when the system is first installed and will also be useful when actuator connections involve long pipe runs. In long pipe runs the volume of fluid in the pipe may often be greater than the displacement of a cylinder, so the fluid will just shuttle backwards and forwards along the pipe (i.e., it will never get back to the system cooler, filter or reservoir). A bypass valve around the cylinder can be opened periodically during maintenance periods to flush new oil into that part of the system.

Make the correct way the easiest way. Adopt the philosophy that the easier it is to do something the more likely it is that it will be done. Also, the correct way of doing something should be made the easiest way of doing it, so that mistakes are less likely to happen.

Handle the unexpected with skilled troubleshooting

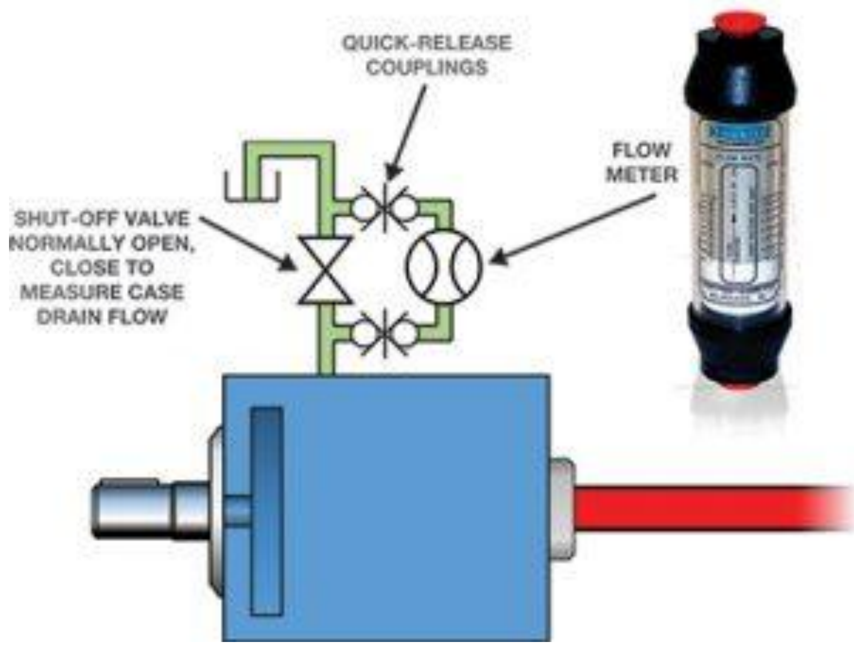


Figure 2. Monitoring pump drain line flow

No matter which maintenance methodology is used and how rigorous the process, there will inevitably be occasions when something unexpected occurs to cause a malfunction in a system or of a machine. This is when troubleshooting skills become necessary, to locate the fault as quickly and accurately as possible. So, whereas maintenance deals with the expected, troubleshooting involves handling the unexpected.

Like maintenance procedures, troubleshooting on hydraulic systems should only be carried out by well-trained, experienced people with a good knowledge of both the machine and the hydraulic system itself. Troubleshooting activities may often involve running a machine in a different way from its normal operation. For example, the machine may have to be operated in manual rather than automatic mode, interlocks or guards may have to be temporarily removed, or directional valve manual overrides may be used instead of normal solenoid operation. During such activities the possibility of dangerous situations arising is much greater than in normal operation, hence the need for well-trained, experienced personnel who are aware of the risks involved and know how to take appropriate measures to minimize them.

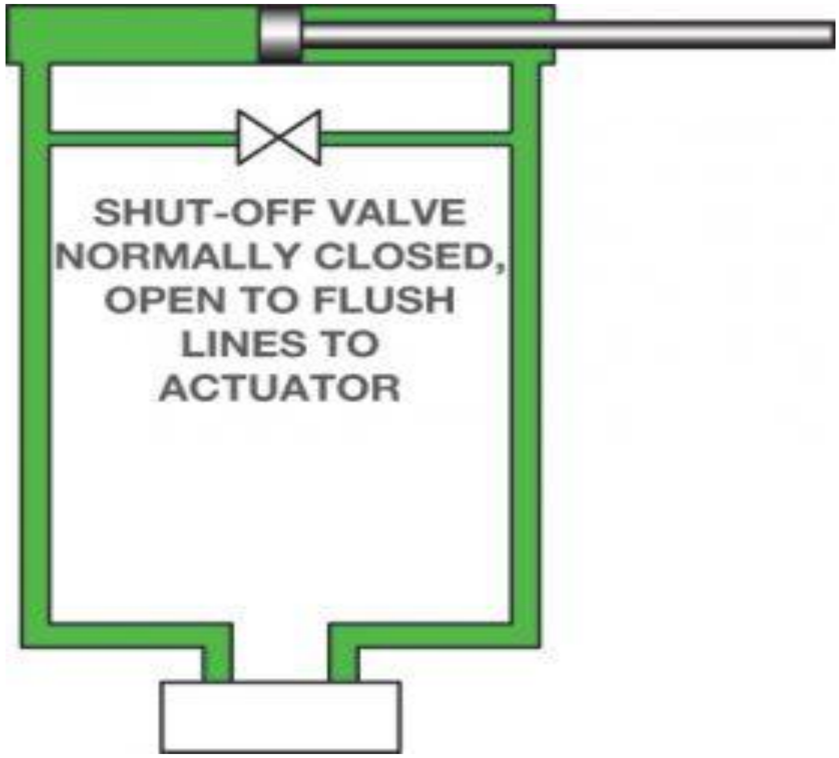


Figure 3: Arrangement for flushing long pipelines

Hydraulic specialists also need to have a good working knowledge of electronic control and communication systems, which are increasingly used in today's machinery. While the integration of electronics in mechanical and hydraulic components has added an extra layer of complexity, the diagnostic capabilities of modern electronics have the potential to simplify troubleshooting activities.

Maintaining Hydraulic Systems (Summary)

Inspections; Maintenance requirements; Fluid level; External leaks; Operating pressure; Fluid quality; Filter maintenance; Reconditioning.

Self-Check -1	Check out Test

Test I: Open ended questions

Directions: **Questions to Ask Yourself (each question have 4.pts)**

1. List the major categories of hydraulic system maintenance.
2. Name and describe the six essential items in a maintenance file.
3. List the steps involved in reconditioning a hydraulic component.
4. Explain how to set up a maintenance plan for a typical hydraulic system

Satisfactory a. above 10 points **Unsatisfactory - below 10 points**

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

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

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