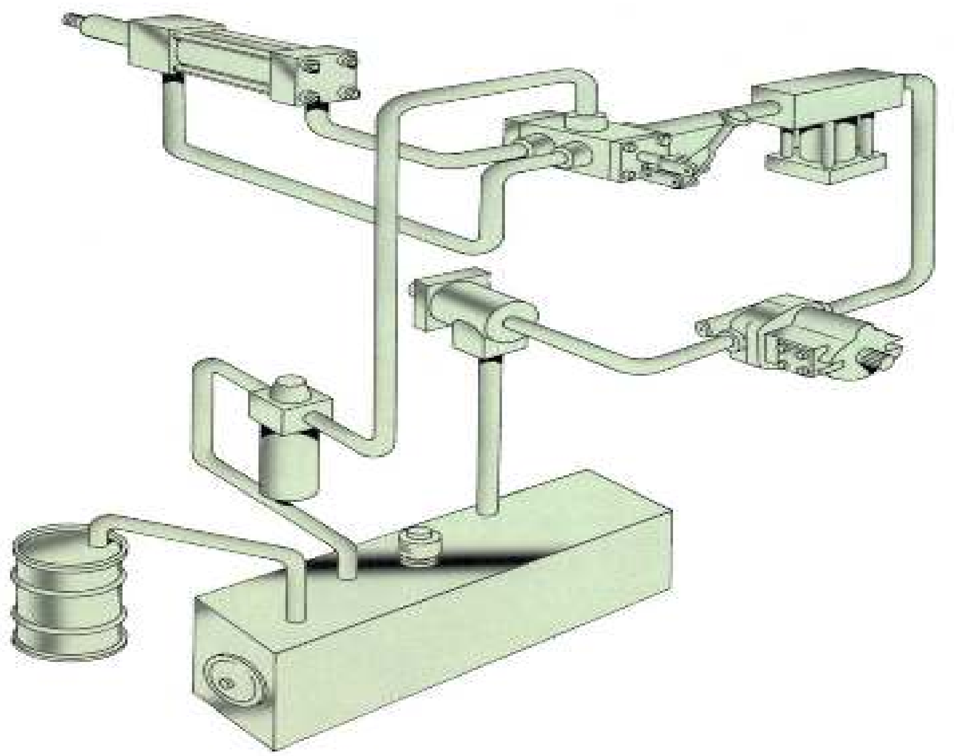
# Mechanics
# Level-II

**Based on March 2022, Curriculum Version 1**



**Module Title: - Installing and Maintaining Fluid Power Pipes and Tubes**

**Module code: IND MCS2 M10 0322**

**Nominal duration: 60 Hour**

**Prepared by: Ministry of Labor and Skill**

**August, 2022**

**Addis Ababa, Ethiopia**

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## Acknowledgment

**Ministry of Labor and Skills** wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

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## Acronym

PPE – Personal Protective Equipment

RPE**-** Respiratory Protective Equipment

OD- outside diameter

ID-Inside Diameter

P - Lode

mm**-** milometer

Nm**-** Newton Meter

HP**-** hour's power

# Introduction to the Module

In Mechanics filed; **Installing and Maintaining Fluid Power Pipes and Tubes** helps to know the pipes and tubes installation, maintenance and repair to pumps, equipment and machineries.

This module is designed to meet the industry requirement under the mechanics occupational standard, particularly for the unit of competency: **Installing and Maintaining Fluid Power Pipes and Tubes**.

**This module covers the units**:

- Fluid Work plan requirement
- set-up work
- Install fluid power pipes and tubes
- cleanup work

**Learning Objective of the Module**

- Apply fluid work techniques
- Set up work
- Perform pipes and tubes Installation
- Clean work

**Module Instruction**

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the "LAP test" giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

# Unit one: Fluid Work plan requirement

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

- apply work instructions
- apply OHS standards
- Type of components, tools and equipment

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

- Apply OHS standards
- Identify types of components, tools and equipment

# 1. Fluid Work Plan Requirement

## 1.1 apply work instructions

### Introduction

In the industry we use three methods for transmitting power from one point to another. Mechanical transmission is through shafts, gears, chains, belts, etc. Electrical transmission is through wires, transformers, etc. Fluid power is through liquids or gas in a confined space.

Fluid power is the technology that deals with the generation, control and transmission of forces and movement of mechanical element or system with the use of pressurized fluids in a confined system. Both **liquids** and **gases** are considered fluids. Fluid power system includes a hydraulic system (hydra meaning water in Greek) and a pneumatic system (pneuma meaning air in Greek). Oil hydraulic employs pressurized liquid petroleum oils and synthetic oils, and pneumatic employs compressed air that is released to the atmosphere after performing the work.

By the term “fluid” refer to air or oil, for it has been shown that water has certain drawbacks in the transmission of hydraulic power in machine operation and control. Commercially, pure water contains various chemicals (some deliberately included) and also foreign matter, and unless special precautions are taken when it is used, it is nearly impossible to maintain valves and working surfaces in satisfactory condition. In the cases where the hydraulic system is closed (i.e., the one with a self-contained unit that serves one machine or one small group of machines), oil is commonly used, thus providing, in addition to power transmission, benefits of lubrication not afforded by water as well as increased life and efficiency of packing and valves.

The application of fluid power is limited only by the ingenuity of the designer, production engineer or plant engineer. If the application pertains to lifting, pushing, pulling, clamping, tilting, forcing, pressing or any other straight line (and many rotary) motions, it is possible that fluid power will meet the requirement.

### 1.1.2 Types of Fluid Power System

Fluid power systems perform work by a pressurized fluid bearing directly on a piston in a cylinder or in a fluid motor. A fluid cylinder produces a force resulting in linear motion, whereas a fluid motor produces torque resulting in rotary motion.

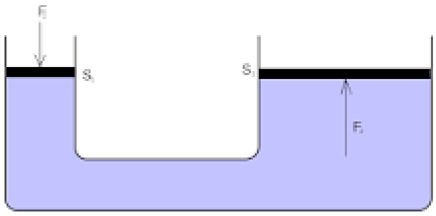


Figure 1Principle of fluid work

The Fluid power system is divided in to two types. They are **hydraulic** and **pneumatic** system depends upon the fluid medium used to transmit force. The hydraulic fluid power system employ liquid (like as water, petroleum, oils and synthetic oils) as fluid medium. The pneumatic fluid power system employs gas (Compressed Air) as the fluid medium

### 1.1.3Advantages of a Fluid Power System

A. Fluid power systems are simple, easy to operate and can be controlled accurately:
B. Multiplication and variation of forces: s of tons.
C. Multifunction control:
D. Low-speed torque:
E. Constant force or torque:
F. Low weight to power ratio:. .
G. Low-speed torque:
H. Constant force or torque:

### 1.1.4Applications of Fluid Power:

1. **Agriculture:** Tractors and farm equipments like ploughs, movers, chemical sprayers, fertilizer spreaders.
2. **Aviation:** Fluid power equipments like landing wheels on airplane and helicopter, aircraft trolleys, aircraft engine test beds.
3. **Building Industry**: For metering and mixing of concrete ingredients from hopper.

4. Construction Equipment: Earthmoving equipments like excavators, bucket loaders, dozers, crawlers, and road graders.
5. **Defense**: Missile-launch systems and Navigation controls
6. Fabrication Industry: Hand tools like pneumatic drills, grinders, bores, riveting machines, nut runners
7. **Food and Beverage**: All types of food processing equipment, wrapping, bottling
8. Foundry: Full and semi-automatic molding machines, tilting of furnaces, die casting machines
9. **Material Handling**: Jacks, Hosts, Cranes, Forklift, Conveyor system.

### 1.2 OHS standards

Employers have duties concerning the provision and use of personal protective equipment (PPE) at work. PPE is equipment that will protect the user against health or safety risks at work. It can include items such as safety helmets, gloves, eye protection, high-visibility clothing, safety footwear and safety harnesses. It also includes respiratory protective equipment (RPE).

#### 1.2.1 Fluid Power Hazards

Hydraulic equipments and systems are designed to accomplish work using confined liquid pressure to produce a greater mechanical force. The operators/ maintenance crews are subjected to hazards from high pressure liquids and large mechanical forces. Fluid power machine systems store fluid under high pressure. The workmen are exposed to following hazards:

- burns from hot, high-pressure fluid
- Injection of fluid into the skin
- Fire Hazards
- bruises, cuts or abrasions from flailing hydraulic lines
- Injury of people due to unexpected movement of equipment**.**

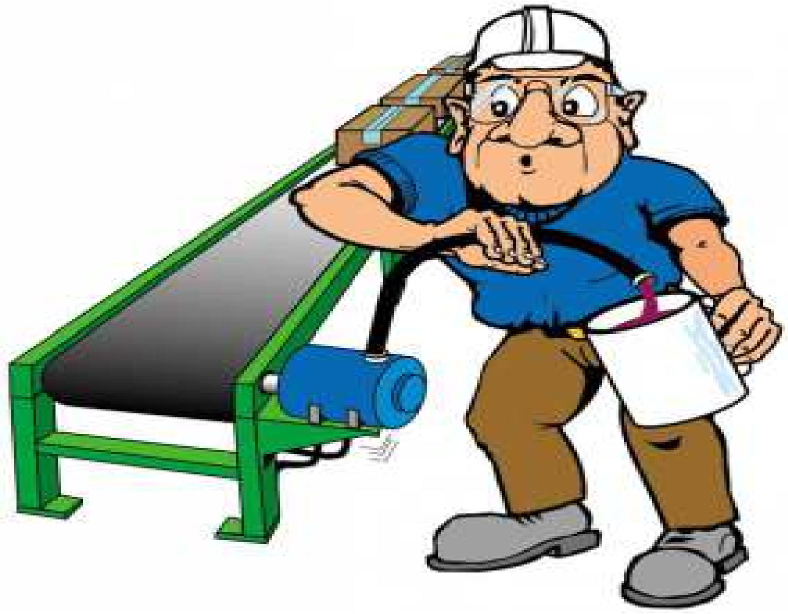


Figure 2 disconnecting the case drain line

**Note: -** leakage is testing procedure by improperly disconnecting the case drain line and holding it in an open receptacle.

### 1.2.2 Color Coding for Safety

Color warnings mark physical hazards, indicate the location of safety equipment, and identify fire and other protective equipment.

The MIL-STD-101 establishes the color code used to identify piping carrying hazardous fluids. It applies to all piping installations in naval industrial plants and shore stations where color coding is used.

Five classes of materials have been selected to represent the general hazards for all dangerous materials, while a sixth class has been reserved for fire protection materials. A standard color represents each of these classes, as shown in Table 2. In some instances, piping systems that do not require warning colors may be painted to match surroundings; in other instances, such systems may be painted aluminum or black or remain unpainted.

Table 1 Warning Colors

| Class | Standard Color | Identification Marking | Class of Material |
|---|---|---|---|
| A | **Yellow** | FLAM | **FLAMMABLE MATERIALS**. All materials known ordinarily as flammables or combustibles. Of the chromatic colors, yellow has the highest coefficient of reflection under white light and can be recognized under the poorest conditions of illumination. |
| B | **Brown** | TOXIC | **TOXIC AND POISONOUS MATERIALS**. All materials extremely hazardous to life or health under normal conditions as toxics or poisons. |
| C | **Blue** | AAHM | **ANESTHETICS AND HARMFUL MATERIALS**. All materials productive of anesthetic vapors and all liquid chemicals and compounds hazardous to life and property but not normally productive of dangerous quantities of fumes or vapors. |
| D | **Green** | OXYM | **OXIDIZING MATERIALS**. All materials which readily furnish oxygen for combustion, and fire producers which react explosively or with the evolution of heat in contact with many other materials. |
| E | **Gray** | PHDAN | **PHYSICALLY DANGEROUS MATERIALS**. All materials not dangerous in themselves, but which are asphyxiating in confined areas or which are generally handled in a dangerous physical state of pressure or temperature. |
| F | **Red** | FPM | **FIRE PROTECTION MATERIALS**. Materials provided in piping systems or in compressed gas cylinders for use in fire protection. |

**General safety precautions during maintenance of fluid power machine System**

Positive isolation procedure to be followed before start of any fluid power machine

- Depressurize the system before start of work. Shut down/ Local Isolation may be taken, if required.
- Never begin work on a hydraulic system until fully trained.
- Never begin work on a hydraulic system without using a risk assessment.
- Carefully review the manuals on equipments before beginning work. Ask questions about anything you do not fully understand.
- Read the Material Safety Data Sheet (MSDS) for chemicals used.
- Use all required safety Equipments.
- Never try to repair a part without having full knowledge about it.
- Each hydraulic system must have a documented procedure of de-energizing and load locking. This should be known to all maintenance personnel.
- Document and practice de-pressurizing procedure in each of the circuit.
- While testing the system after repair never stand close to the unit. Any component, pipe, hose, fitting may fail.
- Before start of work, drain the pressure line through minimesh point upto the actuator.
- Drain the accumulator, if any, from drain valve and check oil pressure from minimess coupling provided in safety block or main pressure line after accumulator. (Refer Fig.-3 and Fig.– 4). If pressure gauge is showing zero, then also bleed the accumulator with minimess hose for confirmation.
- During the tightening of pressurized lines hammering should not be done.
- Tightening of Joints should be done in depressurized condition.
- In any of the hydraulic maintenance jobs, all other agencies working in that area should be well communicated about the hydraulic work and its effects.

Figure 3 Arrow in the picture is showing drain valve

Figure 4 the arrow in the picture is showing minims' point

### 1.3 Type of components, tools and equipment

Fluid power is called hydraulics when the fluid is a liquid and is called pneumatics when the fluid is a gas. Hydraulic systems use liquids such as petroleum oils, synthetic oils, and water. Pneumatic systems use air as the gas medium because air is very abundant and can be readily exhausted into the atmosphere after completing its assigned task.

### 1.3.1 Basic Components of a Hydraulic System

Hydraulic systems are power-transmitting assemblies employing pressurized liquid as a fluid for transmitting energy from an energy-generating source to an energy-using point to accomplish useful work. There are six basic components required in a hydraulic system:

1) Tank (reservoir) to hold the hydraulic oil.
2) Pump to force the oil through the system.
3) An electric motor or other power source to drive the pump.
4) Valves to control oil direction, pressure, and flow rate.
5) An actuator to convert the pressure of the oil into mechanical force to do the useful work.
6) Piping to carry the oil from one location to the other.

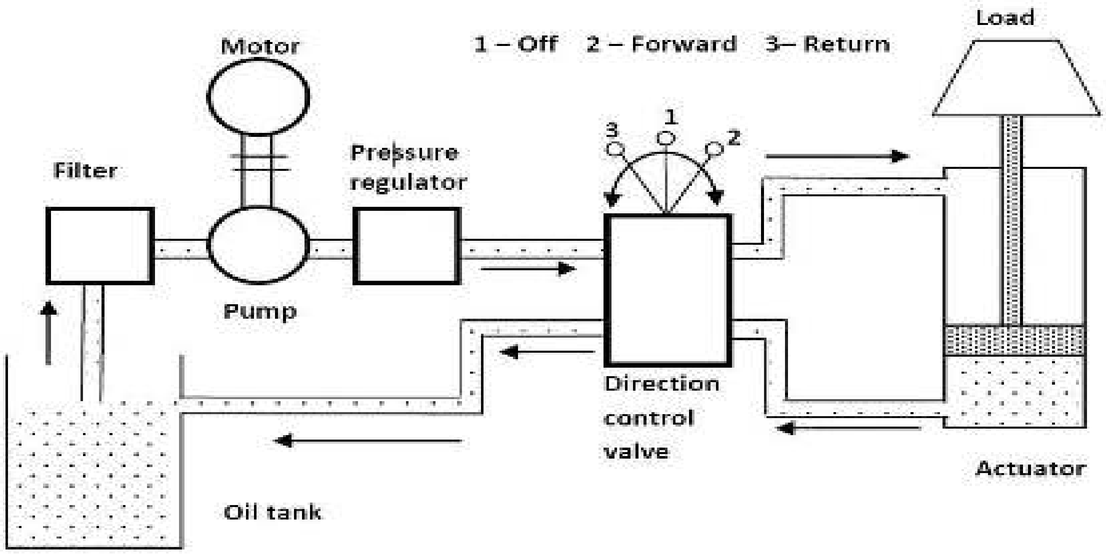



Figure 5 basic components hydraulic system

**Pressure regulator**

Functions of the components shown in Fig. 6 are as follows:

1. The hydraulic actuator is a device used to convert the fluid power into mechanical power to do useful work. The actuator may be of the linear type (e.g., hydraulic cylinder) or rotary type(e.g., hydraulic motor) to provide linear or rotary motion, respectively.

2. The hydraulic pump is used to force the fluid from the reservoir to rest of the hydraulic circuit by converting mechanical energy into hydraulic energy.
3. Valves are used to control the direction, pressure and flow rate of a fluid flowing through the circuit.
4. External power supply (motor) is required to drive the pump.
5. Reservoir is used to hold the hydraulic liquid, usually hydraulic oil.
6. Piping system carries the hydraulic oil from one place to another.
7. Filters are used to remove any foreign particles so as keep the fluid system clean and efficient, as well as avoid damage to the actuator and valves.
8. Pressure regulator regulates (i.e., maintains) the required level of pressure in the hydraulic fluid.

**1.3.2 Basic Components of a Pneumatic System**

A pneumatic system carries power by employing compressed gas, generally air, as a fluid for transmitting energy from an energy-generating source to an energy-using point to accomplish useful work. Figure 1.3 shows a simple circuit of a pneumatic system with basic components.

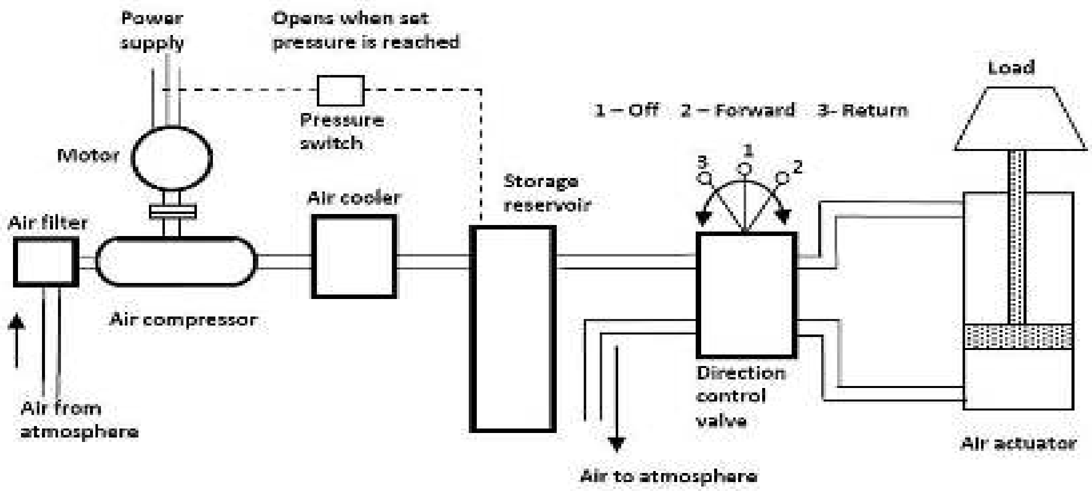



Figure 6basic components of pneumatics

The functions of various components shown in Fig. 7 are as follows:

1. The pneumatic actuator converts the fluid power into mechanical power to perform useful work.
2. The compressor is used to compress the fresh air drawn from the atmosphere.
3. The storage reservoir is used to store a given volume of compressed air.
4. The valves are used to control the direction, flow rate and pressure of compressed air.
5. External power supply (motor) is used to drive the compressor.
6. The piping system carries the pressurized air from one location to another.
7. Air is drawn from the atmosphere through an air filter and raised to required pressure by an air compressor.

As the pressure rises, the temperature also rises; hence, an air cooler is provided to cool the air with some preliminary treatment to remove the moisture. The treated pressurized air then needs to get stored to maintain the pressure. With the storage reservoir, a pressure switch is fitted to start and stop the electric motor when pressure falls and reaches the required level, respectively.

The three-position change over the valve delivering air to the cylinder operates in a way similar to its hydraulic circuit.

**Comparison between Hydraulic and Pneumatic Systems**

Usually hydraulic and pneumatic systems and equipment do not compete. They are so dissimilar that there are few problems in selecting any of them that cannot be readily resolved. Certainly, availability is one of the important factors of selection but this may be outweighed by other factors. In numerous instances, for example, air is preferred to meet certain unalterable conditions, that is, in “hot spots” where there is an open furnace or other potential ignition hazard or in operations where motion is required at extremely high speeds. It is often found more efficient to use a combined circuit in which oil is used in one part and air in another on the same machine or process.

Table 2Comparison between a hydraulic and a pneumatic system</table>

| | Hydraulic System | Pneumatic System |
|---|---|---|
| 1 | It employs a pressurized liquid as a fluid | It employs a compressed gas, usually air, as a fluid |
| 2 | An oil hydraulic system operates at pressures up to 700 bar | A pneumatic system usually operates at 5–10 bar |
| 3 | Generally designed as closed system | Usually designed as open system |
| 4 | The system slows down when leakage occurs | Leakage does not affect the system much |
| 5 | Valve operations are difficult | Valve operations are easy |
| 6 | Heavier in weight | Lighter in weight |
| 7 | Pumps are used to provide pressurized liquids | Compressors are used to provide compressed gases |
| 8 | The system is unsafe to fire hazards | The system is free from fire hazards |
| 9 | Automatic lubrication is provided | Special arrangements for lubrication are needed |

| Self-Check -1 | Written Test |
|---|---|

**PART-I: Write "TRUE" if the statement is correct and "FALSE" if it is wrong statement.**

1. Hydraulic power is especially useful when performing heavy work.
2. Water is a good functional hydraulic fluid
3. Pneumatic system is not free from fire hazards.
4. Pneumatic System Pumps are used to provide pressurized liquids
5. hydraulic system operates at pressures up to 5-10 bar

**PART-II: Select the best answer from the given alternatives and write its letter on the space provided**

1. a type of component used for remove any foreign particles

   A. Reservoir B. Filters hydraulic C. pump D. Valves

2. A type of component is used to control the direction, pressure and flow rate of a fluid flowing through the circuit.

   A, hydraulic actuator B. hydraulic pump C. Valves D. motor

3. One of the following is in correct about Hydraulic System
   A. It employs a pressurized liquid as a fluid
   B. The system slows down when leakage occurs
   C. Carry Heavier weight compare to pneumatic
   D. Compressors are used to provide compressed oil
4. Which one of the following is not correct about fluid power safety
   A. Depressurize the system before start of work
   B. Tightening of Joints should be done in depressurized condition
   C. try to repair a part without having full knowledge about it
   D. None
5. a type of component used for hold the hydraulic liquid, usually hydraulic oil

   A. Reservoir B. Hydraulic actuator C. hydraulic pump D, Valves

**PART-III: Match the items listed under column "A" with those expressions listed under "B"**

| **"Column A"** | **"Column B"** |
|---|---|
| _____1. Carry the fluid from one location to the other | A. hydraulic actuator |
| _____2. Fresh air drawn from the atmosphere | B Pressure regulator |
| _____3.Component of pneumatic fluid power system | C Compressor |
| _____4componet of hydraulic fluid power system | D piping system |
| _____ 5.device used to convert the fluid power into mechanical | E. pump |

**PART IV Sort answer**

1. List three methods for transmitting power from one point to another
2. Mention Classification of Fluid Power Systems
3. List at list 5 Advantages of a Fluid Power System

| LAP Test | Practical Demonstration |
|---|---|

Task 1: Identify hydraulic and pneumatic component from the given diagram.

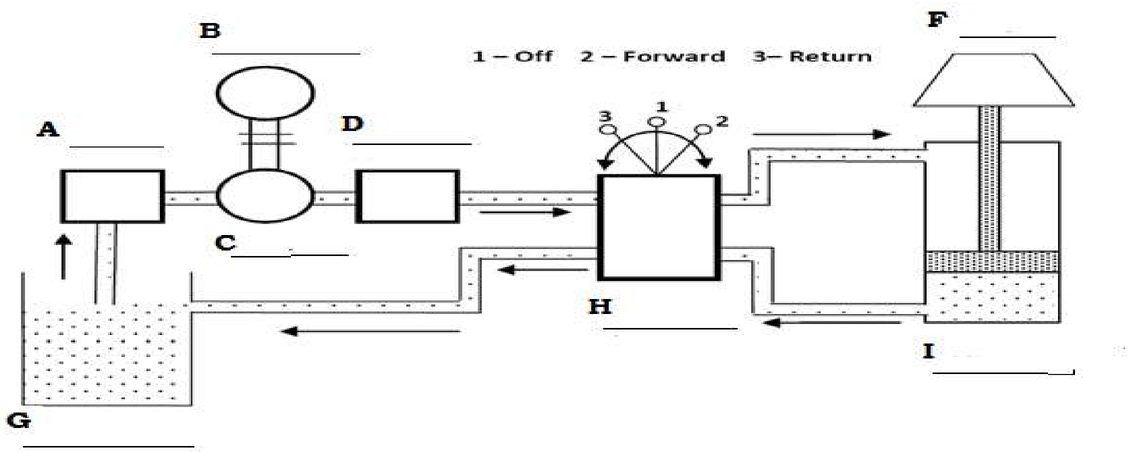
Task 2: Describe the function of fluid power components. from the given diagram.

Task 3 much the given drawing (diagram)

Diagram

1. Select from the table and Fill the name of the hydraulic component on the given blank space

| | | | |
|---|---|---|---|
| 1. pressure regulator | 3. Filter, | 5. motor, | 7. pump, |
| 2. directional control valve | 4. oil tank | 6. actuator | 8. Load |




1. Select from the table and Fill the name of the pneumatic component system on the given blank space

| | | | |
|---|---|---|---|
| 1 Air compressor | 2. Filter, | 3. motor, | 4. Air actuator |
| 5.In late Air from atmosphere | 6. Air cooler | 7. Storage reservoir | 8. Directional control valve |

## Unit Two: Prepare and set-up work

This unit to provide you the necessary information regarding the following content coverage and topics:

- Identify Faults
- methods of repairing fault
- Types of pipes and fittings
- tools and equipment
- Circuit functions and components

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

- Identify Faults
- apply methods of repairing fault
- Identify Types of pipes and fittings
- select tools and equipment
- Map out Circuit functions and components

## 2. Prepare and set-up work

### 2.1. Identify Faults

One of the big challenges to maintenance fluid power is finding faults. Sometimes it's need better experience to perform this task.

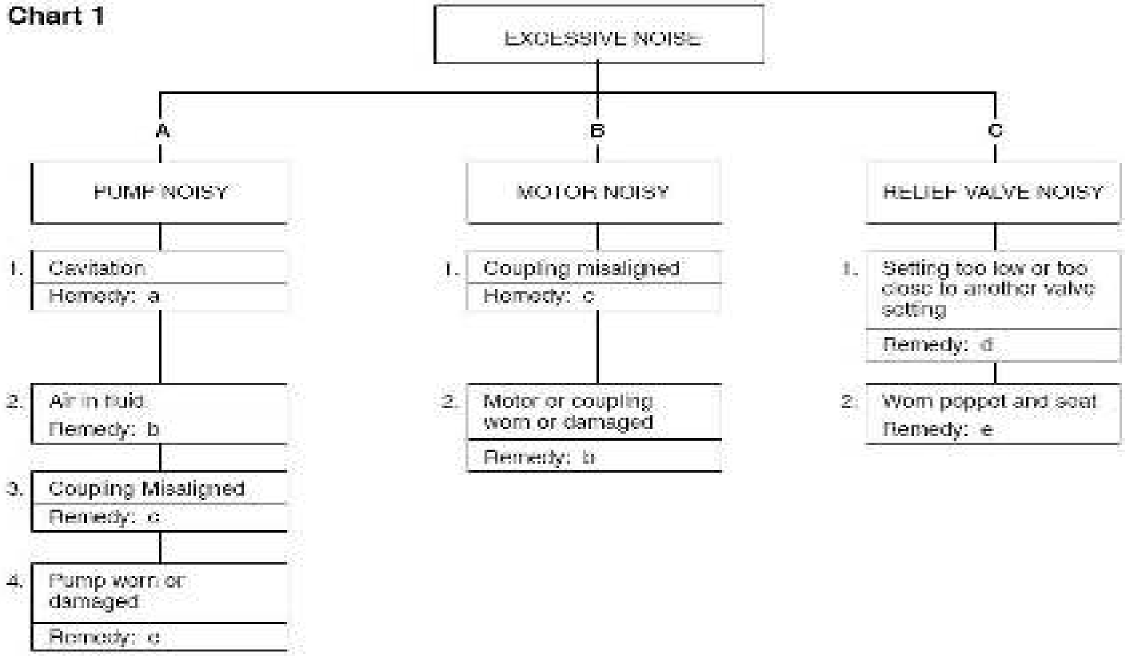
There are three maintenance levels. **First-line maintenance is concerned with getting faulty plant running again**. When the cause of a fault is found, first-line staff has the choice of affecting a first-line, on-site, repair (by replacing a failed seal, say) or changing the complete faulty unit for a spare. This decision is based on cost, time, availability of spares, technical ability of staff, and the environment on site and company policy.

**Second-line maintenance** is concerned with repair to complete units changed by first-line maintenance staff. It should be performed in clean and well-equipped workshops. Work is usually well-defined and is often a case of following manufacturers' manuals. The final level is simply the return of equipment for repair by the manufacturer. The level at which this is needed is determined by the complexity of equipment, ability of one's staff, cost and the turn-

### 2.2 Methods of Repairing Fault

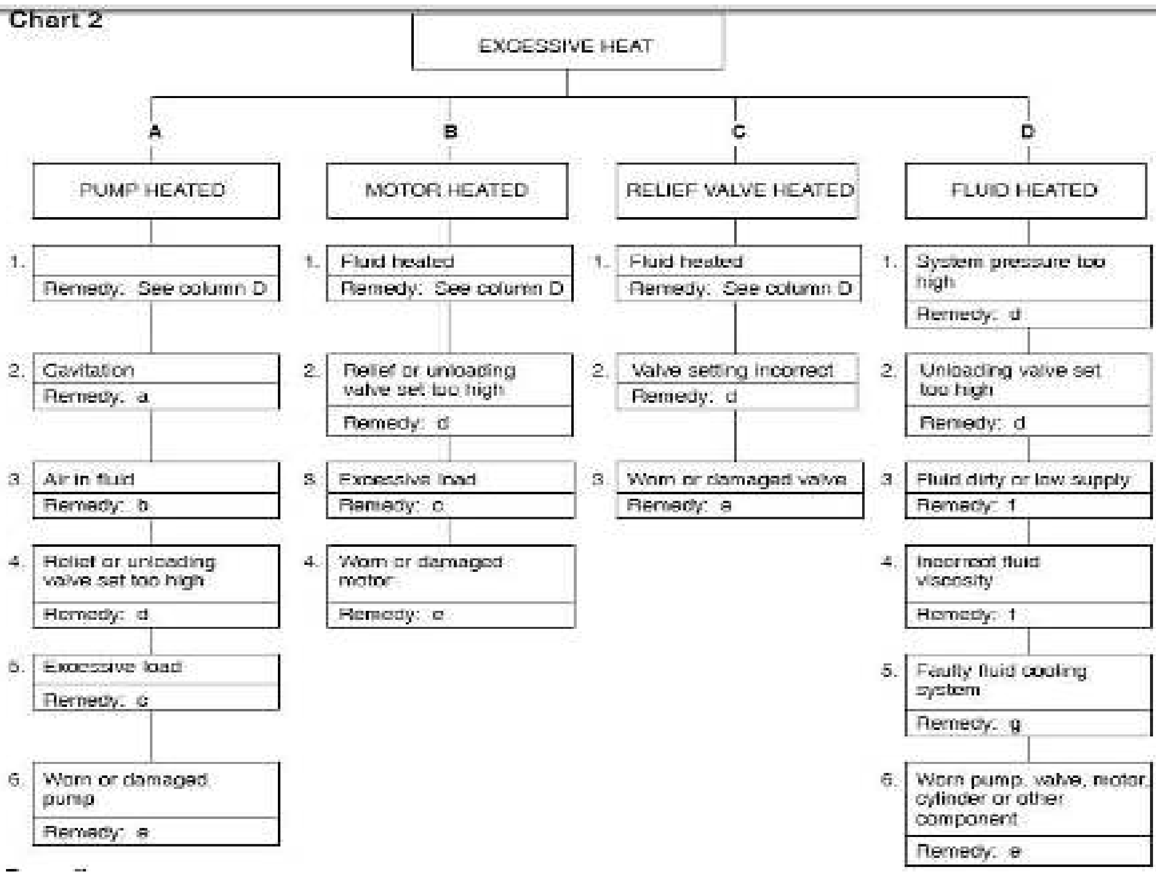
There are different methods to repairing fault of fluid power operated machine and pipe lines Regardless of the type of lines or connectors used to make up a fluid power system, make certain they are the correct size and strength and perfectly clean on the inside. All lines must be absolutely clean and free from scale and other foreign matter. Iron or steel pipes, tubing, and fittings can be cleaned with a boiler tube wire brush or with commercial pipe cleaning apparatus. Rust and scale can be removed from short, straight pieces by sandblasting, provided there is no danger that sand particles will remain lodged in blind holes or pockets after the piece is flushed. Some fluid power components are frequently faller during the operation such as excessive noise, excessive heat, incorrect pressure (pressure loss), fault operation etc…The following methods are help to identify faults and easily repair the fluid power components.

Chart 1



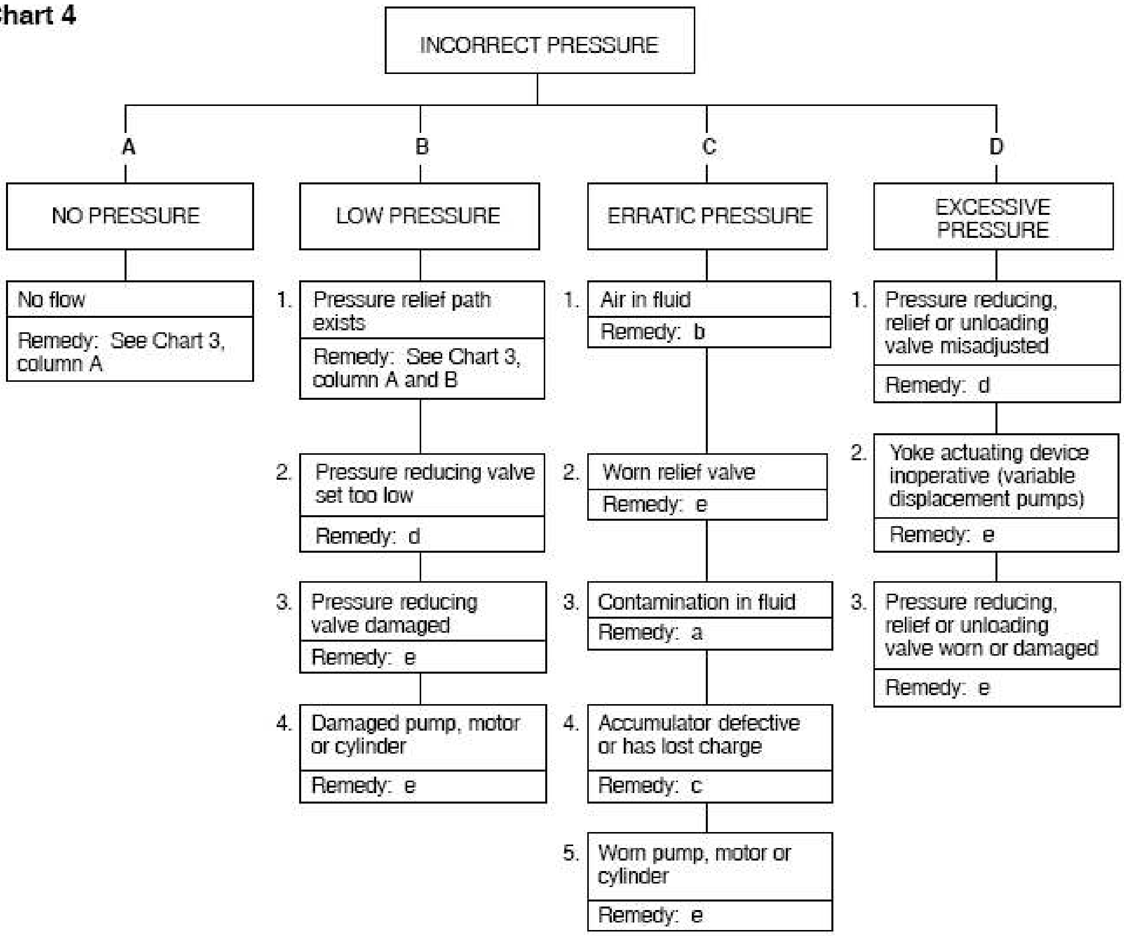

| Remedies: | |
|---|---|
| **a. Any or all of the following:-**<br>• Replace dirty filters;<br>• wash strainers in solvent compatible with system fluid;<br>• clean clogged inlet line;<br>• clean or replace reservoir breather vent;<br>• change system fluid; change to proper pump drive motor speed;<br>Overhaul or replace supercharge pump; fluid may be too cold. | **b. Any or all of the following:**<br>• Tighten leaking connections;<br>• Fill reservoir to proper level (with rare exception all return lines should be below fluid level in reservoir);<br>• Bleed air from system; replace pump shaft seal.<br><br>**c**. Align unit and check condition of seals, bearings and coupling. correct pressure<br><br>d, Install pressure gauge and adjust to correct pressure<br>e. Overhaul or replace |

Chart 2



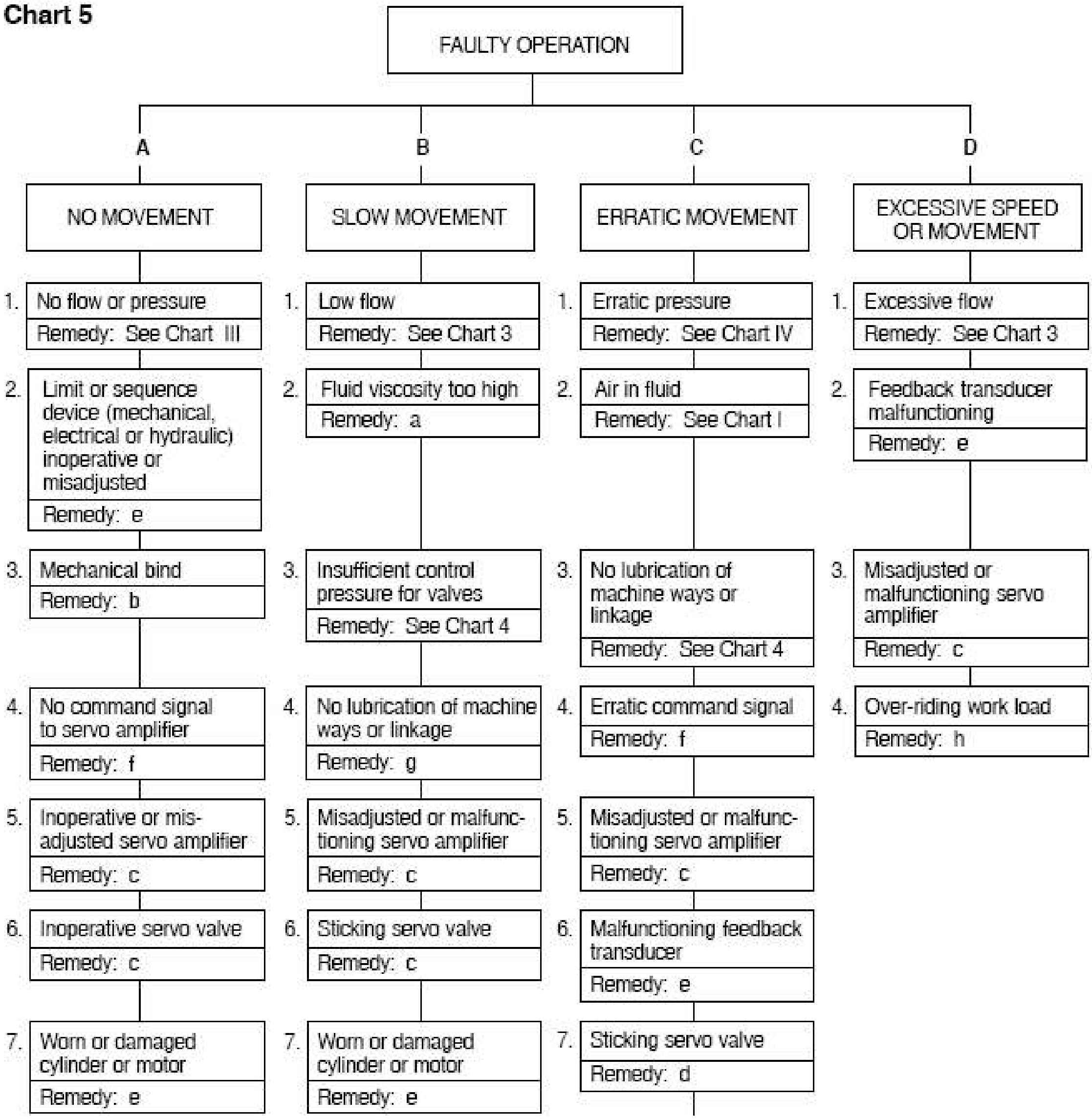

<table>
<tr><th colspan="2">Remedies:</th></tr>
<tr><td>
a. Any or all of the following:<br>
• Replace dirty filters;<br>
• clean clogged inlet line;<br>
• clean or replace reservoir<br>
• change system fluid;<br>
• change to proper pump drive motor speed;<br>
• Overhaul or replace supercharge pump.<br>
b. Any or all of the following:<br>
• Tighten leaking connections;<br>
• Fill reservoir to proper level<br>
• Bleed air from system;<br>
• replace pump shaft seal .
</td><td>
C, Any or all of the following:<br>
• Align unit and check condition of seals and bearings;<br>
• locate and correct mechanical binding;<br>
• Check for work load in excess of circuit design.<br>
d, Any or all of the following:<br>
• Install pressure gauge and adjust to correct pressure (keep at least 125 PSI difference between valve settings).<br>
e. Overhaul or replace.<br>
f. Change filters and also system fluid if improper viscosity; fill reservoir to proper level<br>
g Any or all of the following:<br>
• Clean cooler and/or cooler strainer;<br>
• replace cooler control valve;<br>
• Repair or replace cooler.
</td></tr>
</table>

**Chart 4**




| Remedies |
|---|
| a. Replace dirty filters and system fluid.<br><br>b. Tighten leaking connections (fill reservoir to proper level and bleed air from system). |
| |

**Chart 5**




<table>
<tr><th colspan="2">Remedies:</th></tr>
<tr><td>a. Fluid may be too cold or should be changed to clean fluid of correct viscosity.<br><br>b. Locate bind and repair Adjust, repair or replace.<br><br>d. Clean and adjust or replace; check condition of system fluid and filters.<br><br>e. Overhaul or replace.</td><td>F, Repair command console or interconnecting wires.<br><br>g. Lubricate.<br><br>h. Adjust, repair or replace counterbalance valve.</td></tr>
</table>

### 2.3 Types of pipes and fittings

Pipe and fittings are widely demanded for any piping and plumbing systems used in industrial and commercial applications. Fittings allow pipes to be joined or installed in the appropriate place and terminated or closed where necessary. Fittings are available in various shapes and sizes. They can be expensive, require time, and different materials and tools to install. They are an essential part of piping and tubing systems. There are many different types of connectors and fittings provided for this purpose. Each type of pipe or tube requires its own type of fitting, but usually all pipe fittings share some common features.

#### 2.3.1 Types of Tubing, Piping, and Hose

There are three types of lines products used in transfer fluid one component to another.

1. Tubing (semi rigid),
2. pipe (rigid), and
3. Hose (flexible).

A number of factors are considered when the type of line product is selected for a particular system. These factors include the type of fluid, the required system pressure, and the location of the system. For example, heavy pipe might be used for a large stationary system, but comparatively lightweight steel tubing is used in the automotive brake system.

The advantages of tubing include easier bending and flaring, fewer fittings, better appearance, better reusability, and less leakage. However, pipe is cheaper and will handle large volumes under high pressures. Pipe is also used where straight-line hookups are required and for more permanent installations.

In either case, the hydraulic lines must be compatible with the entire system. Pressure loss in the line must be kept to a minimum for an efficient system.

Pipes for hydraulic systems should be made of seamless cold-drawn mild steel. Galvanized pipe should NOT be used because the zinc coating could flake or scale, causing damage to the valves and pumps.

Tubing used in fluid power systems is commonly made from steel, copper, aluminum, and, in some instances, plastic. Each of these materials has its own distinct advantages or disadvantages in certain applications. Some tubing materials are listed below

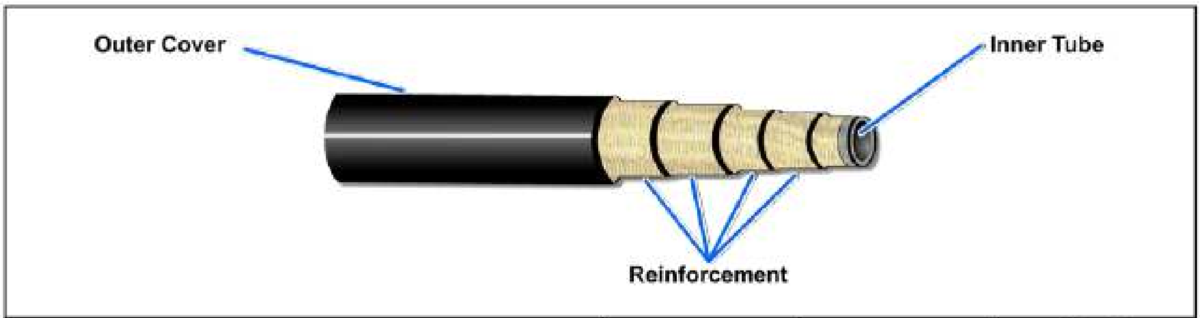
- **Copper;-**The use of copper is limited to low-pressure hydraulic systems where vibration is limited. Copper has high resistance to corrosion and is easily drawn or bent. However, it is unsatisfactory for high temperatures and has a tendency to harden and break due to stress and vibration.
- **Steel:-**Tubing constructed of cold-drawn steel is the accepted standard in hydraulics where high pressures are encountered. Steel is used because of its strength, stability for bending and flanging, and adaptability to high pressures and temperatures. Its chief disadvantage is its comparatively low resistance to corrosion. There are two types of steel tubing- seamless and electric welded.
- **Aluminum:-**Tube is limited to low-pressure use, yet it has good flaring and bending characteristics.
- **Plastic**:-Plastic tubing lines are made from a variety of materials; nylon is the most suitable for use in low-pressure hydraulic applications ONLY.

**Flexible Hose**

Hose is used in fluid power systems where there is a need for flexibility, such as connection to units that move while in operation or to units attached to a hinged portion of the equipment. It is also used in locations that are subjected to severe vibration. Flexible hose is usually used to connect the pump to the system. The vibration that is set up by the operating pump would ultimately cause rigid tubing to fail. Shock-resistant, flexible hose assemblies are required to absorb the movements of mounted equipment under both normal operating conditions and extreme conditions. They are also used for their noise-attenuating properties and to connect moving parts of certain equipment.

There are two basic types of hoses used in aircraft and related equipment. They are **synthetic rubber** and **poly tetra fluoro ethylene** (PTFE), commonly known as Teflon

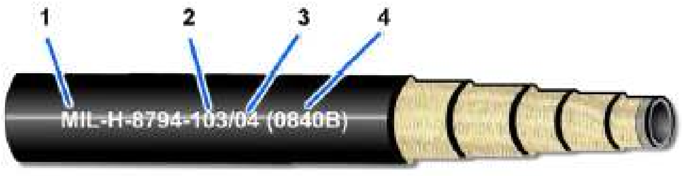
**Rubber hoses are designed** for specific fluid, temperature, and pressure ranges and are provided in various specifications. Rubber hoses (Figure 5) consist of a minimum of three layers; a seamless synthetic rubber tube reinforced with one or more layers of braided or spiralled cotton, wire, or synthetic fibre; and an outer cover. The inner tube is designed to withstand the attack of the fluid that passes through it. The braided or spiralled layers determine the strength of the hose; the greater the number of these layers, the greater the pressure rating. Hoses are provided in three **pressure ranges: low, medium, and high**. The outer cover is designed to withstand external abuse and contains identification markings.




| Construction material | | | Intended Use | Cautions | Use To Fabricate Hose Assy |
|---|---|---|---|---|---|
| Inner Tube | Reinforcement | Outer Cover | | | |
| Synthetic rubber compound, seamless construction, resistant to: petroleum base fuel, lubricating oil, hydraulic fluid | Inner cotton braid and wire braid | Synthetic rubber impregnated cotton braid, resistant to: oil (petroleum base) | Medium-pressure hydraulic, fuel, and petroleum base oil system applications | | MIL-DTL-8795 |

Figure 7 Medium pressure synthetic rubber hose.

Synthetic rubber hose (if rubber-covered) is identified by the indicator stripe and markings that are stencilled along the length of the hose. The indicator stripe (also called the lay line because of its use in determining the straightness or lie of a hose) is a series of dots or dashes. The markings (letters and numerals) contain the specification, hose size, cure date, and manufacturer's Federal supply code number. This information is repeated at intervals of 9 inches (Figure 6).




Synthetic Rubber Hose

1. Military specification of hose
2. Size indicated by a dash (-) No. or fraction of an inch for MIL-DTL-6000 hose
3. Cure date for age control
4. Manufacturer's Federal Supply Code No.


Wire Braid Covered Synthetic Rubber Hose

| | |
|---|---|
| Manufacturer | ACME |
| Manufacturer's code | 0840B |
| Part No. with dash (size) No. | AB123-10 |
| Lot No. | 16160 |
| Operating pressure | 3000 PSI |
| Military specification | MIL-H-83298 |

Wire Braid Covered PTFE Hose Label

Figure 8 Synthetic rubber hose identification.

Size is indicated by a dash followed by a number (referred to as a dash number). The dash number does not denote the inside or outside diameter of the hose. It refers to the equivalent outside diameter of rigid tube size in sixteenths (1/16) of an inch. dash 8 (-8) mates to a number 8 rigid tube which has an outside diameter of one-half inch (8/16). The inside of the hose will not be one half inch, but slightly smaller to allow for tube thickness. The cure date is provided for age control. It is indicated by the quarter of the year and year. The year is divided into four quarters.

- 1st quarter — January, February, March
- 2rd quarter — April, May, June
- 3rd quarter — July, August, September
- 4th quarter — October, November, December

Synthetic rubber hose (if wire-braid covered) is identified by bands wrapped around the hose at the ends and at intervals along the length of the hose. Each band is marked with the same information (Figure 9).

### Acceptance Life

The acceptance life for synthetic rubber hoses is the period of time from the cure date to the acceptance by the organizational-, Intermediate-, or Depot-level activity. Synthetic rubber hose and hose assemblies must have at least 8 1/2 years (34 quarters) of the shelf life remaining upon acceptance from the first Government activity receiving the material from the manufacturer.

### Poly tetra fluoro ethylene (PTFE) (Teflon) Hose

The PTFE hose is a flexible hose designed to meet the requirements of higher operating pressures and temperatures in present fluid power systems. This type of hose is made from a chemical resin, which is processed and extruded into a tube shaped to a desired size. It is reinforced with one or more layers of braided stainless steel wire or with an even number of spiral wrap layers with an outer wire braid layer.

A PTFE hose is unaffected by all fluids presently used in fluid power systems. It is inert to acids, both concentrated and diluted. Certain PTFE hose may be used in systems where operating temperatures range from −100 to +500 degrees Fahrenheit (°F). PTFE is non flammable; however, where the possibility of open flame exists, a special asbestos fire sleeve should be used.

A PTFE hose will not absorb moisture. This, together with its chemical inertness and anti adhesive characteristics, makes it ideal for missile fluid power systems where none contamination clean lines In lieu of lay line marking, PTFE hoses are identified by metal or pliable plastic bands at their ends and at intervals along their length. Usually the only condition that will shorten the life of PTFE hose is excessive temperature. For this reason there is no manufacture date listed on the identification tag.

### Application

Flexible hose is available in three pressure ranges: low, medium, and high. When replacing hoses, it is important to ensure that the replacement hose is a duplicate of the one removed in length, OD, material, type and contour, and associated markings. In selecting hose, several precautions must be observed. The selected hose must:

1. Be compatible with the system fluid,
2. Have a rated pressure greater than the design pressure of the system,
3. Be designed to give adequate performance and service for infrequent transient pressure peaks up to 150 percent of the working pressure of the hose, and
4. Have a safety factor with a burst pressure at a minimum of 4 times the rated working pressure.

### 2.3.2 Type of fittings

The basic purposes of any pipe fitting are as follows:

- Connecting the bores of two or more pipes or tubes.
- Connecting pipe sections.
- Connecting a pipe to a different apparatus.
- Changing the direction of fluid/liquid flow.
- Maintaining or regulating the flow.
- Closing and sealing a pipe.

Some type of connector or fitting must be provided to attach the lines to the components of the system and to connect sections of line to each other. There are many different types of connectors and fittings provided for this purpose. The type of connector or fitting required for a specific system depends on several factors. One determining factor, of course, is the type of fluid line (pipe, tubing, or flexible hose) used in the system. Other determining factors are the type of fluid medium and the maximum operating pressure of the system..

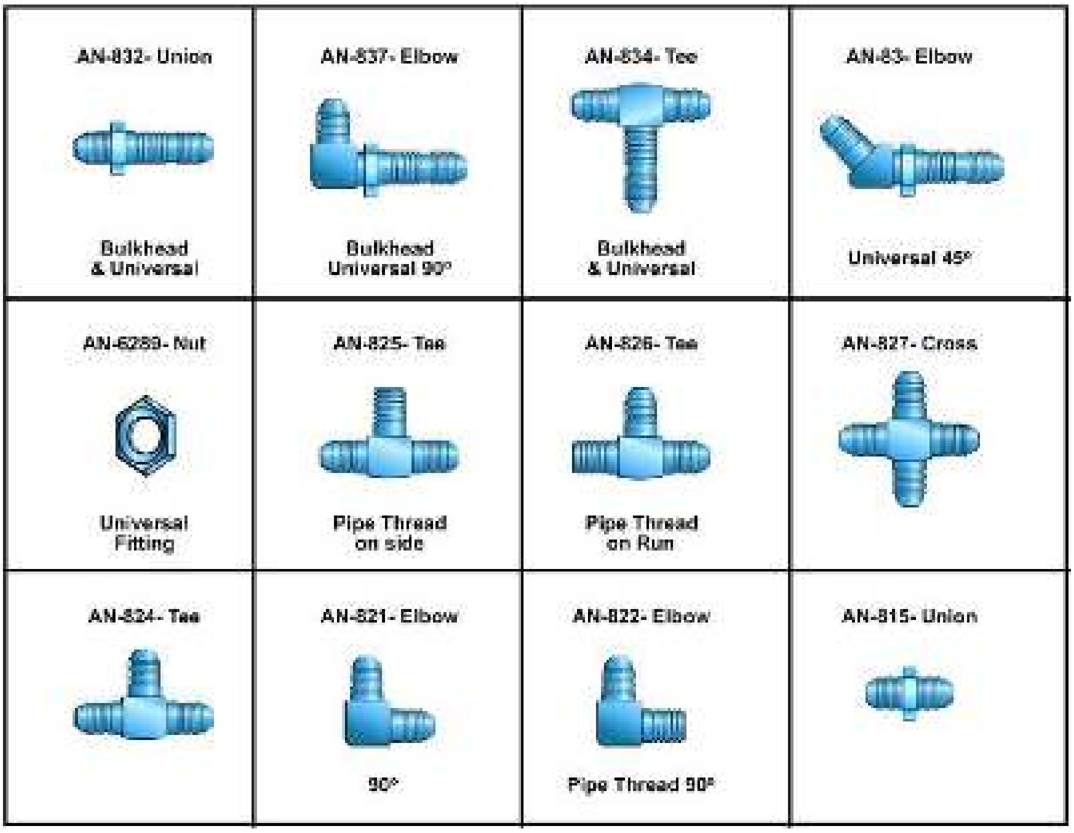
Depending on the purposes served, pipe fittings can be categorized as under:

- Pipe fittings to extend or terminate pipe runs: For example, Couplings, Adapters, Unions, Caps and Plugs Pipe.
- Fittings to change a pipe's direction: For example , Elbows

- Pipe fittings to connect two or more pipes: For example: Tees, Cross, Side-inlet Elbows, Wyes
- Pipe fittings to change pipe size: For example, Reducers, Bushings, Couplings
- Pipe fittings to manage or regulate flow: For example, Valves
- Pipe fitting tools: For example, Pipe fasteners
- Pipe flanges

On the basis of the above categories, we give below an idea about the various types of pipe fittings available in the market.

Table 3 types of pipe fitting




**Selection criteria for pipe fittings:**

Pipe fittings are to be chosen considering certain factors. They are as follows:

- **Connection types**: When purchasing pipe fittings, you should be aware of the fact that a fitting can have two different connector types. One end of the fitting might be female threaded while the other female threaded. One end might be male slip while the other end is threaded, in the case of plastic fittings. They can also have matching ends which can accommodate any requirement.

- **Materials of construction**: As a rule, the pipe fitting should be of the same material as the material used in the making of the pipe in which it is to be fitted. However, in some cases, materials conforming to certain codes or standards can also be used in pipes of another material.
- **Check for flow:** To keep the flow consistent, the ends of pipe fittings should be slightly larger than the rest of the pipe so that they can accommodate connections without narrowing the inner diameter (ID) of the pipe.
- **Type of fitting:** Besides pipe materials, pipe fittings are identified by the type of fitting — threaded or slip, male or female.
- **Size:** When measuring the size of pipe fittings, it is to be noted that the male threaded fittings are measured to the outside edge or OD, while female fittings are measured to the inside edge of the inlet or ID.
- **Thickness:** Just as pipes are available in a number of different thicknesses or "schedules", so also the pipe fittings.
- **Design:** Each pipe or tube is designed to carry certain specific types of fluids, liquids, gases, chemicals under varying conditions. Accordingly, the pipe fittings are also available in variety of designs.
- **Standards and codes**: There are certain standards and codes set by various organizations by which the different pipe fittings are graded. For example, ASTM, ASME, BSP etc. are certain standards assigned to pipe fittings and those standards dictate their use.

### 2.3.3 Sealing Devices and Materials

Sealing devices and materials prevent leakage, and contain pressure or exclude contamination between components. The two most common classifications of seals are **gaskets** and **packing.** There are many commercial types and forms of packing and gasket materials. The Navy has simplified the selection of packing and gasket materials commonly used in service.

## Gaskets and Packing

Gaskets (Figure 10) depend upon mechanical compression to provide a positive seal between two stationary joints, whereas packing generally are used where some form of relative motion occurs between members of the joint. Packing (Figure 10) consists of deformable material, which is shaped by adjustable compression to provide a controlled seal. Certain types of seals (for example, the O-ring, which is discussed later) may be used either as a gasket or a packing.


Figure 9 gasket and packing

The sealing devices and materials used in fluid power systems and components are divided into two general classes — **static seals** and **dynamic seals** (Figure 11).

## Static and Dynamic Seals

The static seal is used to prevent leakage in a mechanical joint where there is no relative motion between mating surfaces. Material used to create a seal between two stationary faces of a mechanical joint are called gaskets. The gasket must function to confine liquids or gasses within an assembly and maintain this seal under various operating conditions.

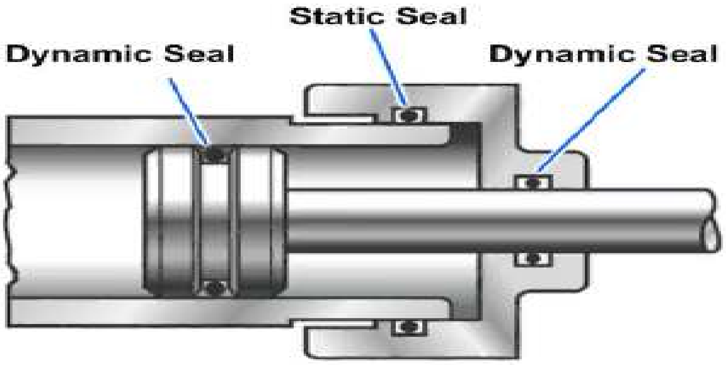



Figure 10 Dynamic seal

To create an effective barrier, gasket material will deform to fill the space between imperfect mating surfaces of mechanical joints to prevent fluids from leaking. This compression requires that the joint be tightly bolted or otherwise held together. The compression of a gasket forming a seal between mating parts is shown in Figure 11.

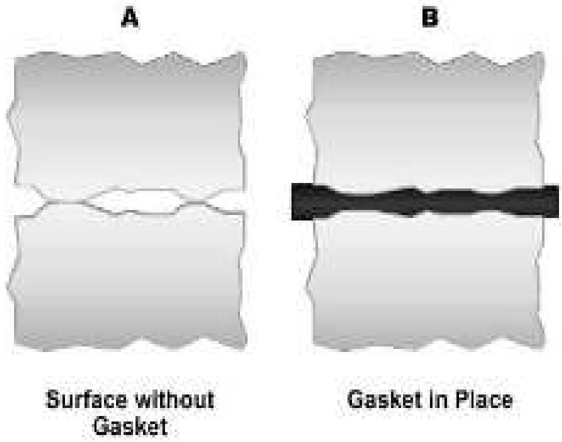



Figure 11 compression of gasket

### 2.4 Tools and equipment

There are different types of tools and equipment for fix to fluid power system. Such type of works needs low to high-pressure tooling and equipment. Thus tools are jacks, cylinders, crimpers, spreaders, cutters, splitters, breakers, drivers, torque wrenches, punches, drills, saws, power tools and more. Some are listed below in fig

Figure 12Bender tools


Figure 13Flange tool


Figure 14Pipe wrench and cutter

## 2.5 Circuit functions and components

### 2.5.1 Basic fluid power component symbols

The installation, modification and troubleshooting of a fluid power system require an understanding of fluid power circuit drawings. Circuit diagrams and the symbols used in them should be drawn to the ISO 1219-1 standard. Before working on a hydraulic system, you should obtain and trace through the circuit drawing to ensure that any potential hazards are identified, so precautions can be taken to avoid personal injury and damage to equipment. It is therefore necessary for you both to be capable of identifying components and to know their function in a circuit.

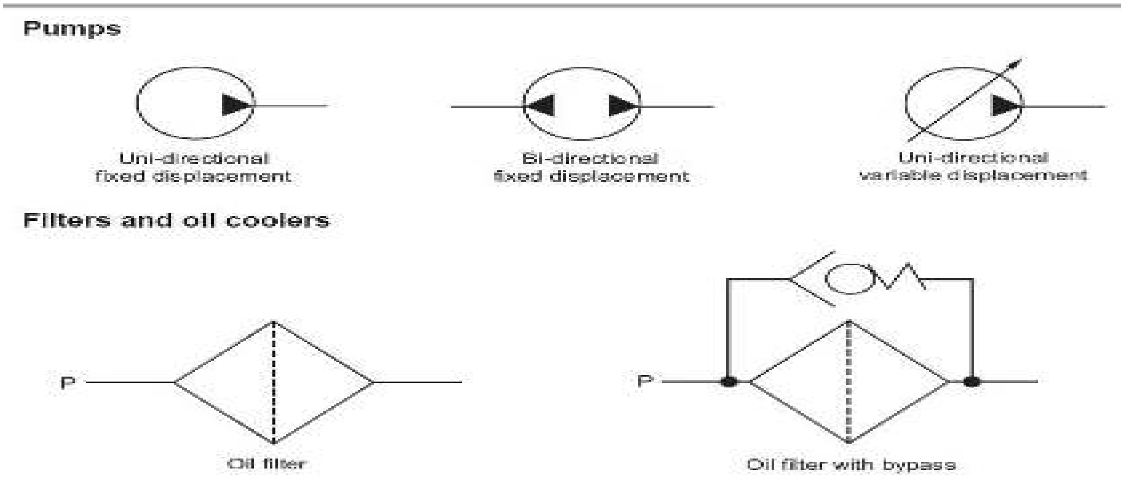
In addition to knowing the symbols illustrated on the following pages, remembering the points below will help you to understand a hydraulic system and be able to identify its components.

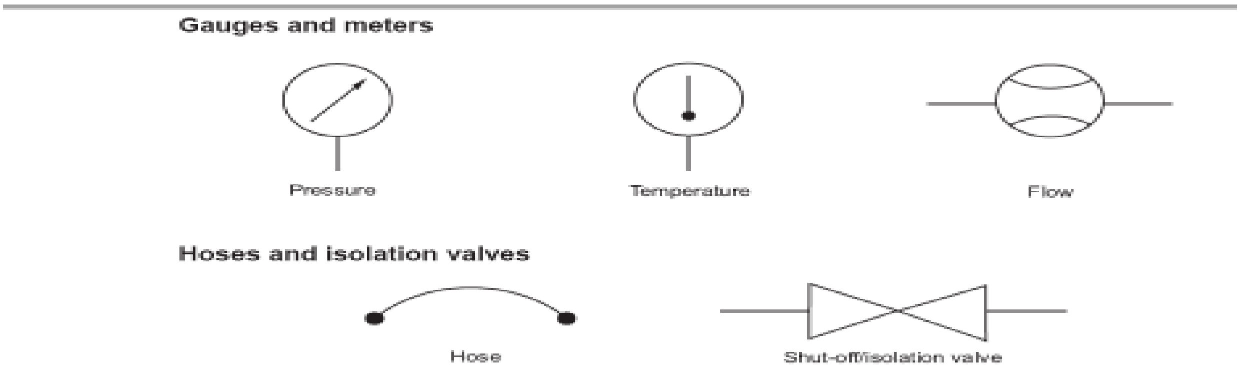
1. The starting point in circuit reading is the reservoir and the termination point is the actuator.
2. Control valves are shown in the de-energized, or neutral, position.
3. When tracing a circuit's operation, mentally move the valve envelopes into the position to give the desired flow.
4. Arrows are used in the envelopes to indicate fluid flow direction.
5. Fluid flow will take the path of least resistance.
6. Identify the basic type of circuit – either open or closed-loop construction.
7. Identify the type of fluid lines connecting the components in the circuit diagram.

**Symbols of components**

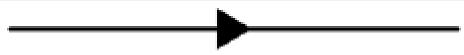
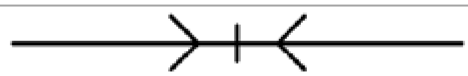
**Reservoirs**

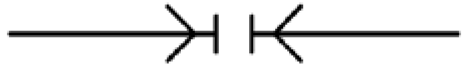
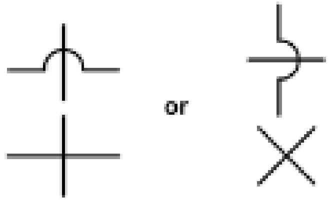
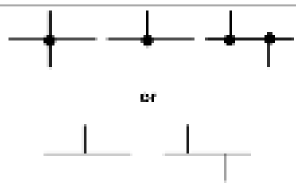

**Check valves**



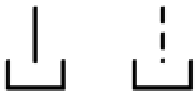
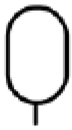
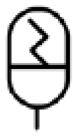
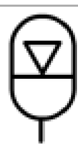



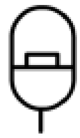
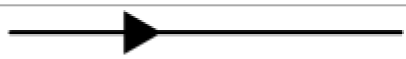

**Fluid Connectors**

| | |
|---|---|
| Line, Working (Main) |  |
| Line, Pilot (for Control) |  |
| Line, Exhaust and Liquid Drain |  |
| Flow, Direction of (Hydraulic) |  |
| Line, Flexible |  |
| Quick Disconnect, Without Checks (Connected) |  |

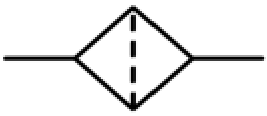
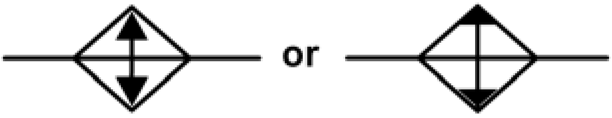
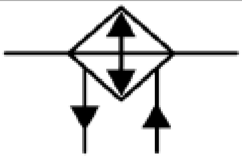
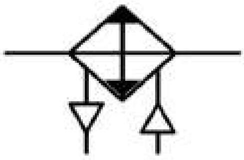
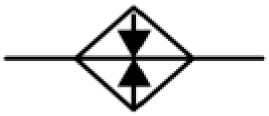
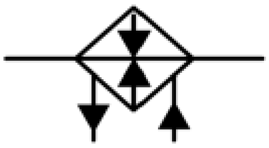
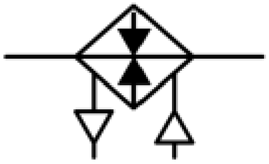
| | |
|---|---|
| Quick Disconnect, Without Checks (Disconnected) |  |
| Line, with Fixed Restriction |  |
| Lines, Crossing |  |
| Lines, Joining |  |

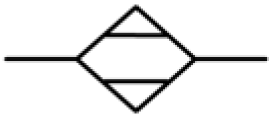
**Energy Storage & Fluid Storage**

| | |
|---|---|
| Reservoir, Vented |  |
| Reservoir, Pressurized |  |
| Reservoir with Connecting Lines Above Fluid Level |  |
| Accumulator |  |
| Accumulator, Spring Loaded |  |
| Accumulator, Gas Charged |  |

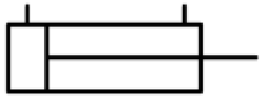
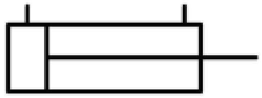
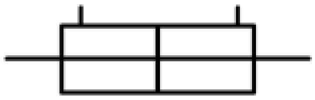
| | |
|---|---|
| Accumulator, Weighted |  |
| Energy Source, Hydraulic<br>(Pump, Compressor, Accumulator, etc.) |  |

**Fluid Conditioners**

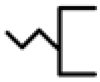
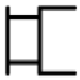
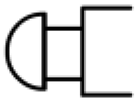
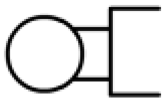
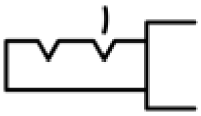
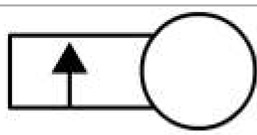
| | |
|---|---|
| Filter-Strainer |  |
| Cooler (inside triangles indicate heat dissipation) | <br> |
| Cooler (outside triangles indicate cooling medium is liquid) |  |
| Cooler (outside triangles indicate cooling medium is gaseous) |  |
| Heater (inside triangles indicate heat introduction) |  |
| Heater (outside triangles indicate heating medium is liquid) |  |
| Heater (outside triangles indicate heating medium is gaseous) |  |

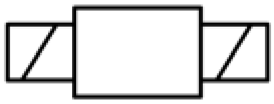
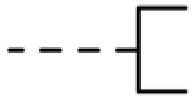
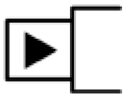
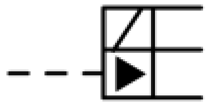
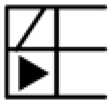
| | |
|---|---|
| Desiccators' (Chemical Dryer) |  |

**Linear Devices**

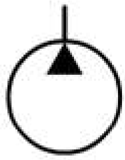
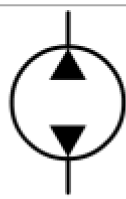
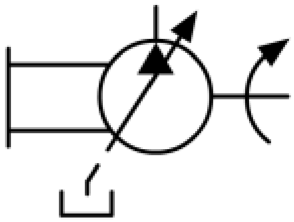
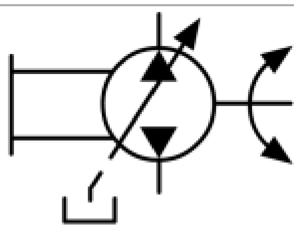
| | |
|---|---|
| Cylinder (Hydraulic & Pneumatic), Single Acting |  |
| Cylinder (Hydraulic & Pneumatic), Double Acting, Single End Rod |  |
| Cylinder (Hydraulic & Pneumatic), Double Acting, Double End Rod |  |

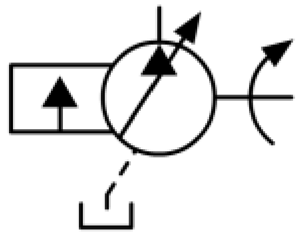
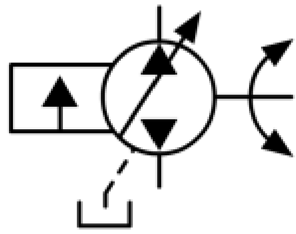
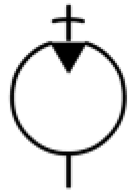
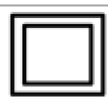
**Actuators and Controls**

| | |
|---|---|
| Spring |  |
| Manual (general symbol without indicating specific type, i.e. foot, hand, leg, arm, etc.) |  |
| Push Button |  |
| Mechanical |  |
| Detent |  |
| Pressure Compensated |  |

| | |
|---|---|
| Electrical Solenoid (Single Winding) |  |
| Pilot Pressure, Remote Supply |  |
| Pilot Pressure, Internal Supply |  |
| Solenoid or Pilot, External Pilot Supply |  |
| Internal Pilot, Supply and Exhaust |  |

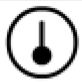
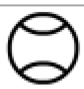
**Rotary Devices**

| | |
|---|---|
| Hydraulic Pump, Fixed Displacement, Unidirectional |  |
| Hydraulic Pump, Fixed Displacement, Bidirectional |  |
| Hydraulic Pump, Variable Displacement, Non Compensated, Unidirectional |  |
| Hydraulic Pump, Variable Displacement, Non Compensated, Bidirectional |  |

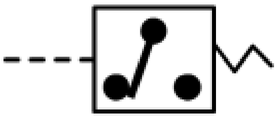
| | |
|---|---|
| Hydraulic Pump, Variable Displacement, Pressure Compensated, Unidirectional |  |
| Hydraulic Pump, Variable Displacement, Pressure Compensated, Bidirectional |  |
| Hydraulic Motor, Fixed Displacement |  |
| Electric Motor |  |
| Heat Engine (e.g. internal combustion engine) |  |

## Instruments & Accessories

### Indicating & Recording

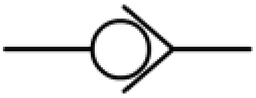
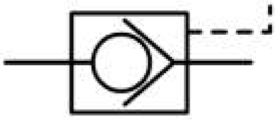
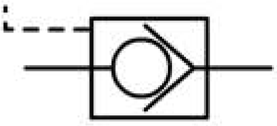
| | |
|---|---|
| Pressure |  |
| Temperature |  |
| Flow Rate Meter |  |

**Accessories**

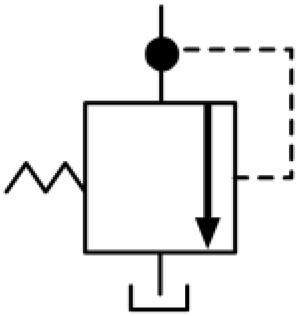
| | |
|---|---|
| Pressure Switch |  |

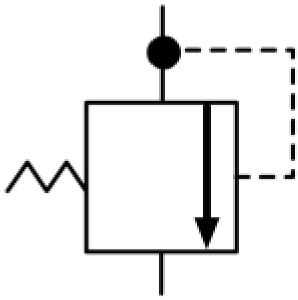
**Valves**

**Two Way Valves (2 Ported Valves)**

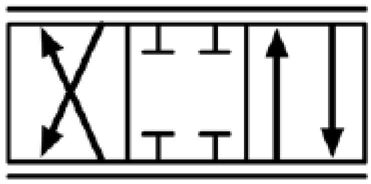
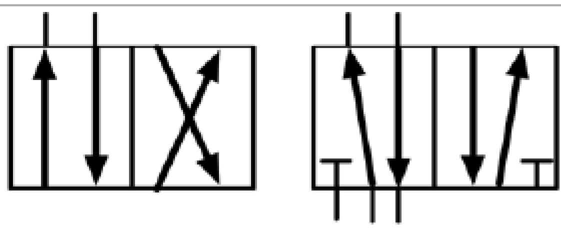
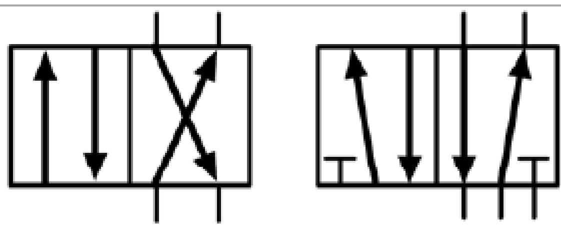
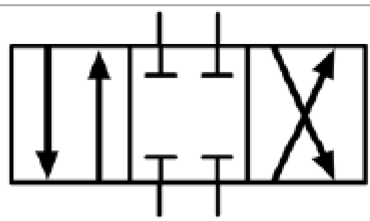
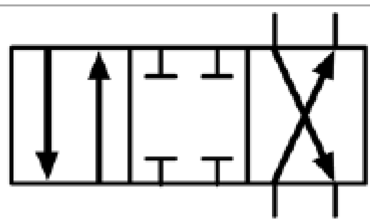
| | |
|---|---|
| On-Off Valve (Manual Shut-Off) |  |
| Check Valve |  |
| Check Valve, Pilot Operated to Open |  |
| Check Valve, Pilot Operated to Close |  |

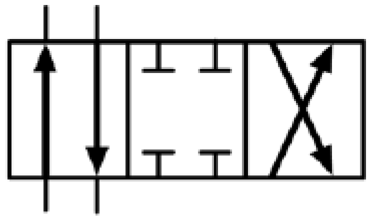
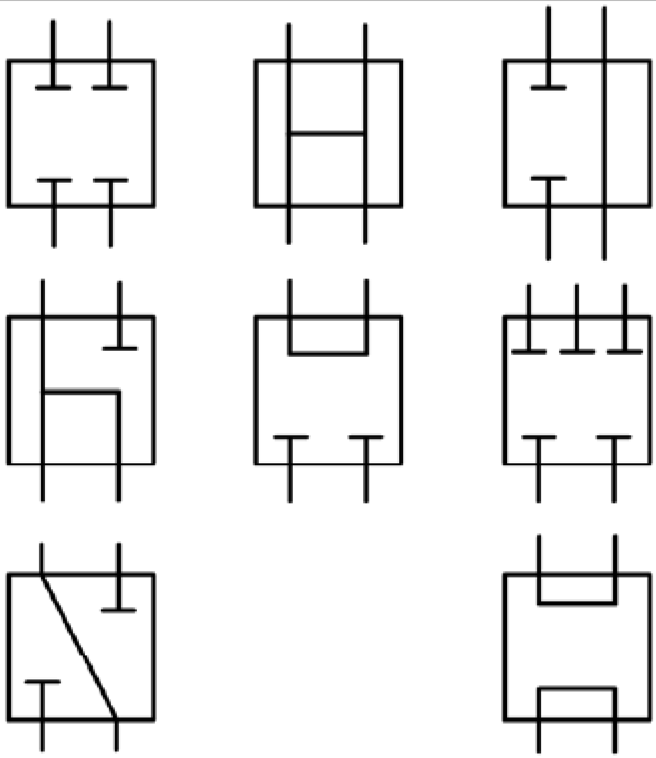
**Pressure Control Valves**

| | |
|---|---|
| Pressure Relief Valve |  |

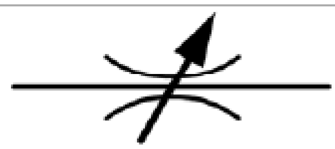
| | |
|---|---|
| Sequence Valve |  |

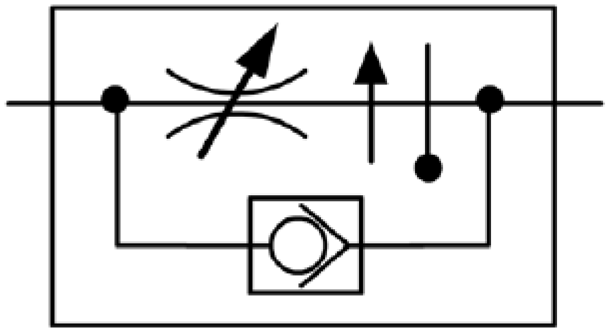
**Four Way Valves**

| | |
|---|---|
| Servovalve, Variable Position (indicated by parallel lines) |  |
| Two Position, Normal |  |
| Two Position, Actuated |  |
| Three Position, Normal |  |
| Three Position, Actuated Left |  |

| | |
|---|---|
| Three Position, Actuated Right |  |
| Typical Flow Paths for Center Condition of Three Position Valves |  |

**Flow Control Valves**

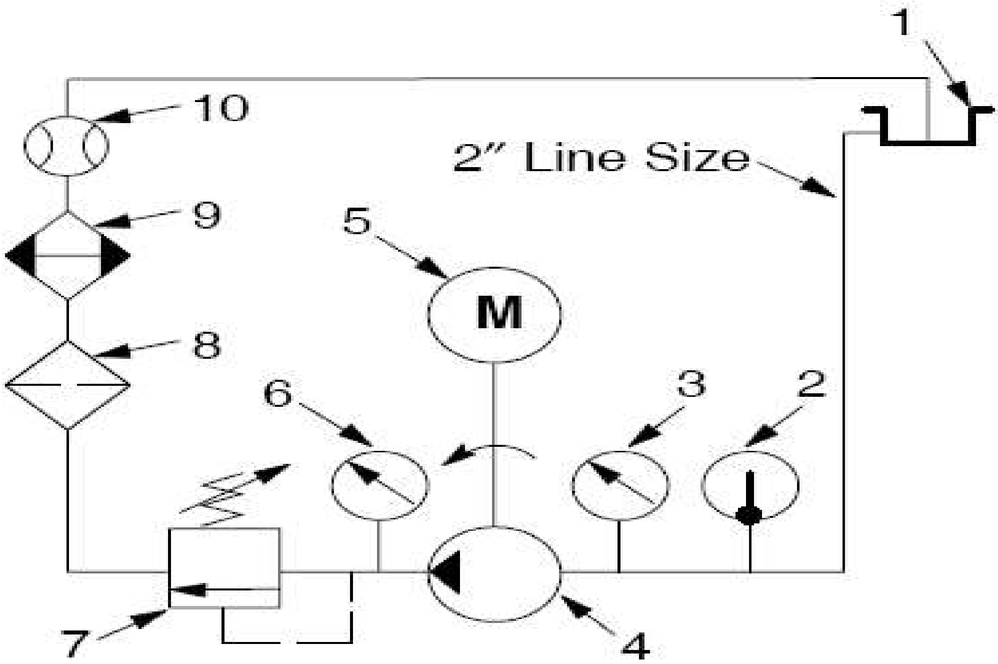
| | |
|---|---|
| Adjustable, Non Compensated (Flow Control in Each Direction) |  |

| | |
|---|---|
| Adjustable, Temperature & Pressure Compensated |  |

### 2.5.2 Basic Circuit diagram

A diagram may be defined as a graphic representation of an assembly or system that indicates the various parts and expresses the methods or principles of operations. The ability to read diagrams is a basic requirement for understanding the operation of fluid power systems. Understanding the diagrams of a system requires having knowledge of the symbols used in the schematic diagrams.

Example



**Description of the above Components**

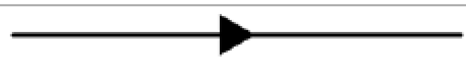
1. Reservoir (50 gallons minimum; elevated above pump centerline to provide gravity feed)
2. Temperature gage or thermocouple
3. Inlet pressure gage
4. Pump: 35VQ25A-11*20 (cartridge kit P/N 413421)
5. Electric motor (125 HP)
6. Outlet pressure gage
7. Pressure relief valve
8. Filter (10 micrometer nominal)
9. Cooler
10. Flow meter

| Self cheek-2 | Written test |
|---|---|

**PART-I: Select the best answer from the given alternatives and write its letter on the space provided**

1. The use of steel pipe is desirable:
   A. when the fluid is conducted along straight pathso
   B. because of its low costo
   C. when use can be made of welding fittingso
   D. all of the aboveo
2. When matching hydraulic fittings and components, the hydraulic technician will need to check the:
   A. type of threado
   B. Angle of any sealing face (seat angle)o
   C. Pressure ratingo
   D. All of the above
3. factors are considered when the type of line is selected for a particular system
   A. Type of fluid
   B. required pressure
   C. location of the system
   D. all
4. One of the fowling lines is used for permanent installations
   A tubing B. line C. hose D none
5. A type of line resists vibration
   A. hose B. tube C pipe D. none

**PART-II: Match the items listed under column "A" with those expressions listed under "B"**

| A | B |
|---|---|
| ________1. Flow, Direction of (Hydraulic) |  |
| ________2. Line, Exhaust and Liquid Drain |  |
| ________3. Line, Flexible |  |
| ________4.Line, Working (Main) |  |
| _______5.Line, Pilot (for Control) |  |

## Operation 1

**Operation Sheet title: -** Prepare and set-up work

**Operation sheet purpose;-** Install basic fluid power circuits

**Instruction:-**Read Basic fluid power circuits and install in accordance with specifications and operational procedures

**Procurers**

**Step 1**- Read and understand work specification or working drawing

**Step 2**- Plan work procedures to perform the work

**Step 3**- Consider OHS policy

**Step4**- Collect fluid power components, pipes, tubes, hoses and accessories based on the information gathered from the drawing

**Step 5**- Select power tools, hand tools and equipments required to accomplish the work

**Step 6**- Plan skill and knowledge /man power/

**Step 7**- Prepare work area

**Step 8**- fix hydraulic or pneumatic components to their respective position

**Step9**- Connect components with the help of piping or hose according to work specification

**Step 10-** Tighten couplings and joints properly

**Step 11**- Check work quality

**Step 12**- Finish work

**Step 13-** report /show/ the work to the responsible personnel

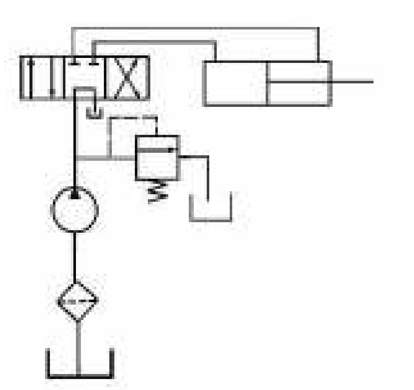
**Step 1**4- clean and return tools and equipment to their proper place

**Step 15** - clean work area

| LAP Test 2 | Practical Demonstration |
|---|---|

**Task 1:** Join and terminate pneumatic and hydraulic line/ piping

**Task 2:** you are given a schematic drawing of a simple hydraulic circuit below, so you are expected to perform a complete practical installation of a circuit.



## Unit Three: Install fluid power pipes and tubes

This unit to provide you the necessary information regarding the following content coverage and topics:

- place Pipes in position
- Join Pipes
- Install Pipe system
- conduct repair

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

- place Pipes in position and size with procedure
- perform joining pipe
- install pipe system
- Conduct repair

.

## 3. Install fluid power pipes and tubes

### 3.1 place Pipes in position

To place pipe in position we should understand the overall fluid power system of the components.

### 3.1.1 Sizing of Pipes

Sizing of Pipes are available in three different weights: standard (STD), or Schedule 40; extra strong (XS), or Schedule 80; and double extra strong (XXS). The schedule numbers range from 10 to 160 and cover 10 distinct sets of wall thickness. (See table 4)Schedule 160 wall thickness is slightly thinner than the double extra strong.

Table 4 standard pipe size

| minal Size | Pipe OD | Inside Diameter [inch] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sched. 10 | Sched. 20 | Sched. 30 | Sched. 40 | Sched. 60 | Sched. 80 | Sched. 100 | Sched. 120 | Sched. 140 | Sched. 160 |
| 1/8 | 0.405 | | | | 0.269 | | 0.215 | | | | |
| 1/4 | 0.540 | | | | 0.364 | | 0.302 | | | | |
| 3/8 | 0.675 | | | | 0.493 | | 0.423 | | | | |
| 1/2 | 0.840 | | | | 0.622 | | 0.546 | | | | 0.466 |
| 3/4 | 1.050 | | | | 0.824 | | 0.742 | | | | 0.614 |
| 1 | 1.315 | | | | 1.049 | | 0.957 | | | | 0.815 |
| 1 1/4 | 1.660 | | | | 1.380 | | 1.278 | | | | 1.160 |
| 1 1/2 | 1.900 | | | | 1.610 | | 1.500 | | | | 1.388 |
| 2 | 2.375 | | | | 2.067 | | 1.939 | | | | 1.689 |

As mentioned earlier, the size of pipes is determined by the nominal (approximate) ID. For example, the ID for a 1/4-inch Schedule 40 pipe is 0.364 inch, and the ID for a 1/2-inch Schedule 40 pipe is 0.622 inch. It is important to note that the IDs of all pipes of the same nominal size are not equal. This is because the OD remains constant and the wall thickness increases as the schedule number increases.

For example, a nominal size 1-inch Schedule 40 pipe has a 1.049 ID. The same size Schedule 80 pipe has a 0.957 ID, while Schedule 160 pipe has a 0.815 ID. In each case the OD is 1.315 (Table 5) and the wall thicknesses are 0.133 [(1.315 - 1.049) / 2], 0.179 [(1.315 - 0.957) / 2], and 0.250[(1.315 - 0.815) / 2] respectively. Note that the difference between the OD and ID includes two wall thicknesses and must be divided by 2 to obtain the wall thickness.

Tubing differs from pipe in its size classification. Tubing is designated by its actual OD (Table 5). Thus, 5/8-inch tubing has an OD of 5/8 inch. As indicated in the table, tubing is available in a variety of wall thicknesses. The diameter of tubing is often measured and indicated in 16ths of an inch. Thus, No. 6 tubing is 6/16 or 3/8 inch, No. 8 tubing is 8/16 or 1/2 inch, and so forth.

Table 5 tubing size designation

Table 5-2: Tubing size designation

| Tube OD | Wall Thickness | Tube ID |
|---|---|---|
| 1/8 | 0.028 | 0.069 |
| | 0.032 | 0.061 |
| | 0.035 | 0.055 |
| 3/16 | 0.032 | 0.1235 |
| | 0.035 | 0.1175 |
| 1/4 | 0.035 | 0.180 |
| | 0.042 | 0.166 |
| | 0.049 | 0.152 |
| | 0.058 | 0.134 |
| | 0.065 | 0.120 |
| 5/16 | 0.035 | 0.2425 |
| | 0.042 | 0.2285 |
| | 0.049 | 0.2145 |
| | 0.058 | 0.1965 |
| | 0.065 | 0.1825 |
| 3/8 | 0.035 | 0.305 |
| | 0.042 | 0.291 |
| | 0.049 | 0.277 |
| | 0.058 | 0.259 |
| | 0.065 | 0.245 |
| 1/2 | 0.035 | 0.430 |
| | 0.042 | 0.416 |
| | 0.049 | 0.402 |
| | 0.058 | 0.384 |
| | 0.065 | 0.370 |
| | 0.072 | 0.358 |
| | 0.083 | 0.334 |
| | 0.095 | 0.310 |
| 5/8 | 0.035 | 0.555 |
| | 0.042 | 0.541 |
| | 0.049 | 0.527 |
| | 0.058 | 0.509 |
| | 0.065 | 0.495 |
| | 0.072 | 0.481 |
| | 0.083 | 0.459 |
| | 0.095 | 0.435 |
| 3/4 | 0.049 | 0.652 |
| | 0.058 | 0.634 |
| | 0.065 | 0.620 |
| | 0.072 | 0.606 |
| | 0.083 | 0.584 |
| | 0.095 | 0.560 |
| | 0.109 | 0.532 |
| 7/8 | 0.049 | 0.777 |
| | 0.058 | 0.759 |
| | 0.065 | 0.745 |
| | 0.072 | 0.731 |
| | 0.083 | 0.709 |
| | 0.095 | 0.685 |
| | 0.109 | 0.657 |
| 1 | 0.049 | 0.902 |
| | 0.058 | 0.884 |
| | 0.065 | 0.870 |
| | 0.072 | 0.856 |
| | 0.083 | 0.834 |
| | 0.095 | 0.810 |
| | 0.109 | 0.782 |
| | 0.120 | 0.760 |
| 1 1/4 | 0.049 | 1.152 |
| | 0.058 | 1.134 |
| | 0.065 | 1.120 |
| | 0.072 | 1.106 |
| | 0.083 | 1.084 |
| | 0.095 | 1.060 |
| | 0.109 | 1.032 |
| | 0.120 | 1.010 |
| 1 1/2 | 0.065 | 1.370 |
| | 0.072 | 1.356 |
| | 0.083 | 1.334 |
| | 0.095 | 1.310 |
| | 0.109 | 1.282 |
| | 0.120 | 1.260 |
| | 0.134 | 1.232 |
| 1 3/4 | 0.065 | 1.620 |
| | 0.072 | 1.606 |
| | 0.083 | 1.584 |
| | 0.095 | 1.560 |
| | 0.109 | 1.532 |
| | 0.120 | 1.510 |
| | 0.134 | 1.482 |
| 2 | 0.065 | 1.870 |
| | 0.072 | 1.856 |
| | 0.083 | 1.834 |
| | 0.095 | 1.810 |
| | 0.109 | 1.782 |
| | 0.120 | 1.760 |
| | 0.134 | 1.732 |

The wall thickness, material used, and ID determine the bursting pressure of a line or fitting. The greater wall thickness in relation to the ID and the stronger the metal, the higher the bursting pressure. However, the greater the ID for a given wall thickness, the lower the bursting pressure, because force is the product of area and pressure.

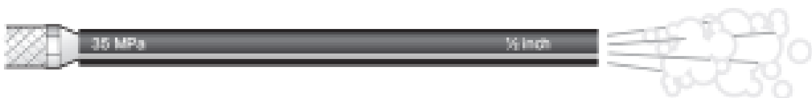
## 3.2 Install and Join Pipe system

### 3.2.1 Installing Pipe and hose

**Hose installation**

1. Measure the effective cut-off length of the hose to suit the installation position

2. Clean out the hose.




3. Fit the hose fittings.

   a) Hold the body by the front hexagonal section horizontally in a vice.

b) Lightly apply oil to the hose cover over a length of about 20 mm from the end.

c. Screw the hose back in a clockwise direction by two-thirds (⅔) of a turn to back it off from the stop (fine thread) by approximately 1.5 to 2.0 mm.

➢ 

e) Remove the hose and body from the vice and visually check that the end of the hose is back from the stop inside the body by approximately 1.5 mm.

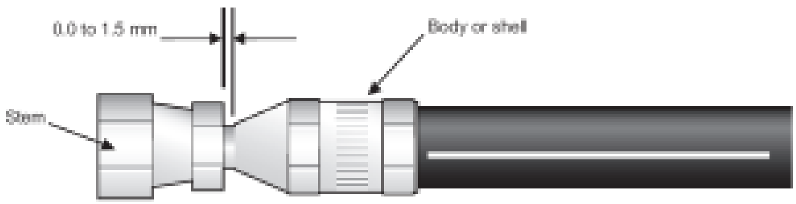
f) Hold the stem by its hexagonal section horizontally in a vice and apply oil to

g) Position the hose and body onto the stem. Avoid 'slicing' of the inner hose tube.

h) Screw the hose and body onto the stem, applying some initial pressure, until the stem thread engages the thread of the body.

i) Hold the body and hose by the front hexagonal section of the body vertically in the vice.

J) Screw the stem in until the shoulder of the stem is between 0.0 and 1.5 m from the face of the body.




4. Maintain a continuous screwing motion to prevent ‘cooling’ off and binding between the stem and the inner tube.
5. Remove the hose assembly from the vice and repeat the fitting operation at the other end.
6. Install and test the hose to work order or site requirements.

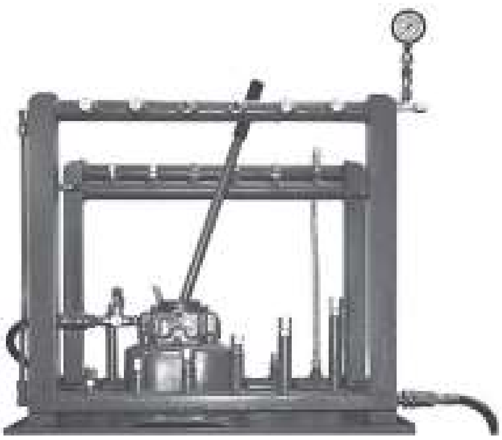


Figure 15 testing hose

**Factors affecting incorrect installation of hose**

Oil flow through a tube pipe or hose affects system performance and component life. The wrong size of hose, pipe or tube can result in the following problems:

- reduced pressure
- system overheating
- vibration
- cavitations (caused by too low a pressure at pump inlet)
- slow actuator response
- turbulent flow
- High back pressure (in return or tank lines).

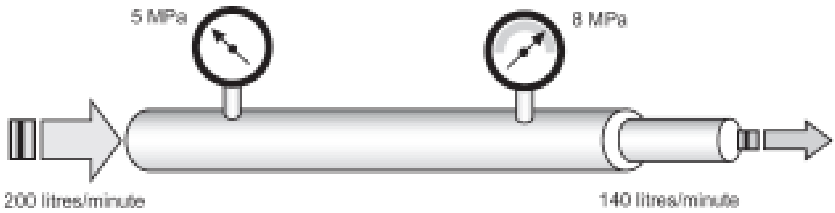



Figure 16 effects of incorrect line size

The above figure illustrates how high back-pressure can be caused by incorrect line sizing. Hydraulic lines (that is, pipe and hoses) are measured by the inside diameter in millimetres. Tube is measured by the outside diameter and wall thickness (but you use internal diameter when utilising a flow rate monogram to determine required size).

When matching hydraulic fittings and components, the hydraulic technician will need to check the:

- type of thread (eg JIC, BSPP, BSPT etc)
- angle of any sealing face (seat angle)
- pressure rating of the fitting.

Hoses are used where there is a degree of movement between components. A hydraulic hose will have a line (usually consisting of the manufacture's name and hose information) running along its length. This is so that the technician can detect any twist in the hose during fitment.



**General hose installation principles**

Remember the following:

- Do not twist the hose. High pressure applied to a twisted hose may cause loosening of the nut or failure of the hose.
- Make sure hose has enough slack to avoid pulling at the nut and allow for thermal contraction and movement.
- Provide as large a bend radius as possible.
- Use clamps and lacing to prevent hose from chafing.
- Do not let the hose lie against hot exhaust-carrying components.

**Installation of pipe**

Steel pipe is used:

- where fluid is to be conducted along straight paths
- because of its low cost compared to hose
- Where use can be made of welding fittings.

**Installation procedures of pipe**

A. Select pipe according to the specification
**B.** Cheek pipe:-All pipes shall be inspected before install to ensure that they are free from loose contamination.
**C.** Prepare permanent temporally supporter :-some pipes needs permanent or temporally
**D.** Place the in position using supporters
**E.** Install gasket: - Gaskets shall be treated in accordance with manufacturers' instructions. Gaskets shall be replaced after opening or dismantling of flange connections. Gaskets are to be lightly smeared on the mating surface with a propriety

anti-friction lubricant prior to fitting between the flange grooves. Anti-friction lubricant, compatible with the flange material and process fluid shall be used.

**F.** Joint the pipe using different connection methods.(Flanges connecting to strain sensitive mechanical equipment e.g. pumps, compressors, turbines, etc. shall be fitted-up in close parallel and lateral alignment prior to tightening the bolting.)

**G.** flushing and testing

**Pipe and tube bending**

While friction increases significantly for sharper curves than this, it also tends to increase up to a certain point for gentler curves. The increases in friction in a bend with a radius of more than 3 pipe diameters results from increased turbulence near the outside edges of the flow. Particles of fluid must travel a longer distance in making the change in direction. When the radius of the bend is less than 2 1/2 pipe diameters, the increased pressure loss is due to the abrupt change in the direction of flow, especially for particles near the inside edge of the flow.

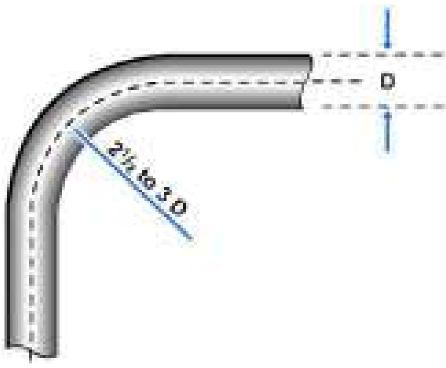



Figure 17 bending technique

At times, new tubing may need to be fabricated to replace damaged or failed lines. Fabrication of tubing consists of four basic operations: cutting, deburring, bending, and joint preparation.

When constructing a tube profile from an engineering drawing, remember that stated dimensions are usually taken from centre-line measurements. This is also the most common method of taking measurements in ‘on the job’ situations, as illustrated below.

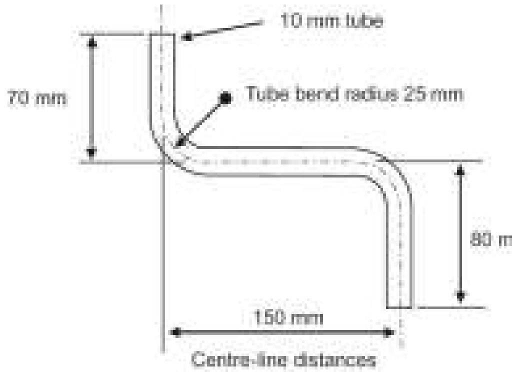
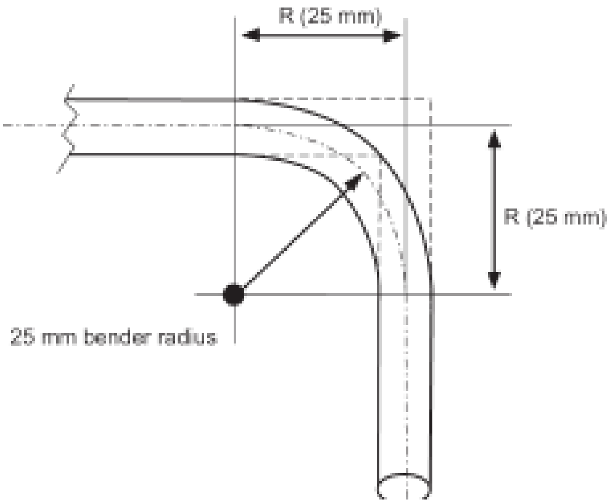



Figure 18 double Bending technique

**Calculating the gain of a 90° bend**

The dimensions of 70 mm, 150 mm and 80 mm shown in the drawing on the previous page would be satisfactory for calculating the pre-cut length of the tube profile if we had square corners. But, when you make a bend with the tube bender, the tube actually follows a curved path, and short cut on the inside of the bend, as shown below.



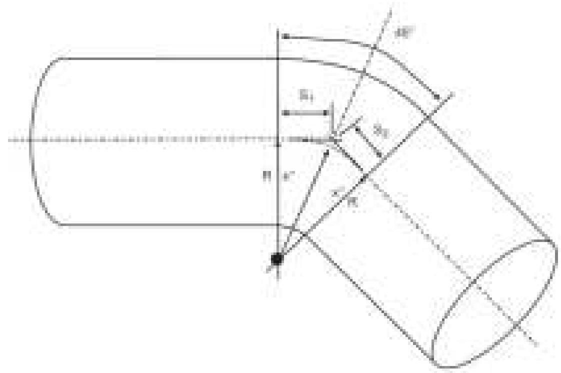
$$\text{The length of the curved tube segment} = \frac{\text{degrees of the arc}}{360^\circ} \times 2\pi R$$

To calculate the reduction in tube length per 90° bend when using a tube bender with a radius of 25 mm, use the following steps.

1. Add the 'equivalent' straight lengths = R + R = 2R = 50 mm
2. Calculate the curved length $= \dfrac{90^\circ}{360^\circ} \times 2\pi R = 39.25$ mm
3. The reduction in tube length = 50 – 39.25 = **10.75 mm**

Please note that the result of this calculation applies only to a 10 mm tube when using a 25-mm tube bender.

**Calculating the gain of a 45° bend**



$$\text{Tan } x = \frac{S_1}{R}$$

$$\therefore S_1 = \text{Tan } 22.5° \times R$$

$$S_1 = \text{Tan } 22.5° \times 25$$

$$S_1 = 0.4142 \times 25$$

$$S_1 = \underline{\mathbf{10.35\ mm}}$$

$$S_1 = S_2$$

To calculate the reduction in tube length per 45° bend when using a tube bender with a radius of 25 mm, use the following steps.

1. Add the straight lengths = $S_1 + S_2$ = 10.35 + 10.35 = 20.7 mm
2. Calculate the curved length = $\frac{45°}{360°} \times 2\pi R = 19.65$ mm
3. The reduction in tube length = 20.7 – 19.65 = **1.05 mm**

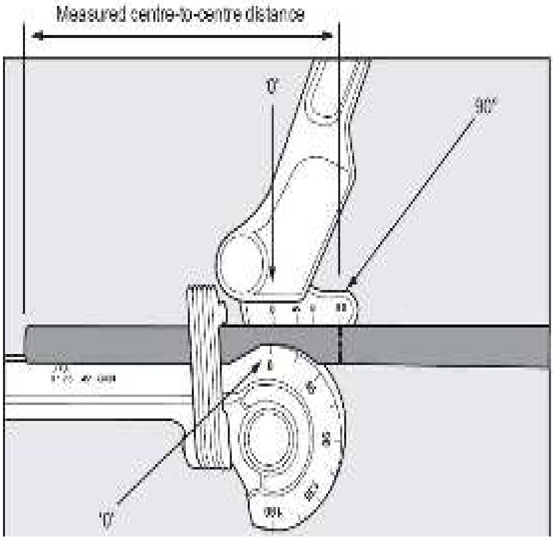
Remember that the result of this calculation applies only to a 10 mm tube when using a 25-mm tube bender.

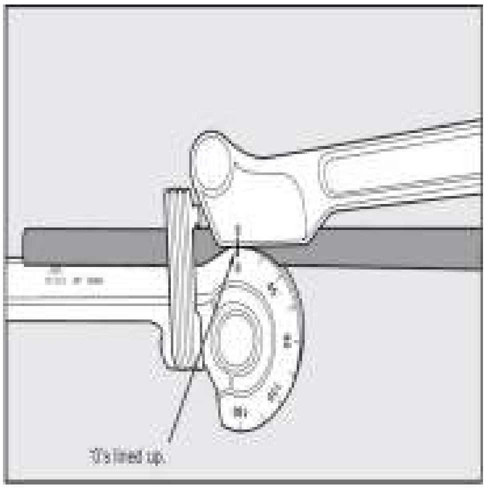
## General rules for tube bending

1. The normal minimum bend radius should not be less than three times the tube diameter. This is a general rule to prevent the tube from distorting – that is, flattening, kinking or wrinkling – and the actual minimum depends upon the gauge (wall thickness) and ductility of the tube.
2. The approximate gain for a 90° bend is equal to the tube diameter. The reduction in tube length will vary according to the size of tube you are bending and the size of the bend radius.
3. A tube bender will have a 'gain scale' on the form handle as illustrated below

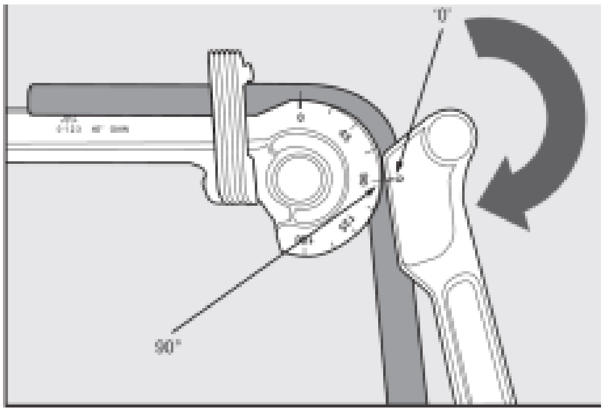
## Making 90° bends

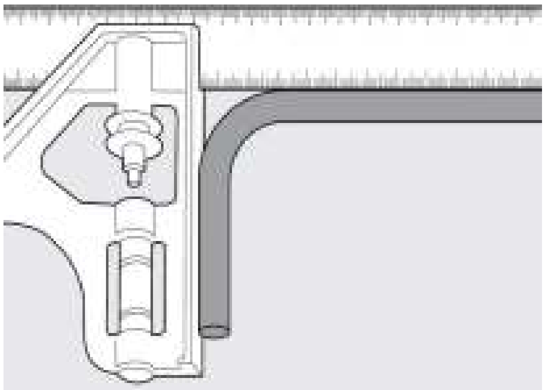
When your measured distance is clamped on the **left-hand side**, line up your mark with the '90°' mark on the link and line up the '0's, as pictured below. (To produce a 45° bend, you would line up your measured distance with the '45°' mark on the link) Clamp the tube with the latch.




Close the shoe handle and line up the ‘0’s.

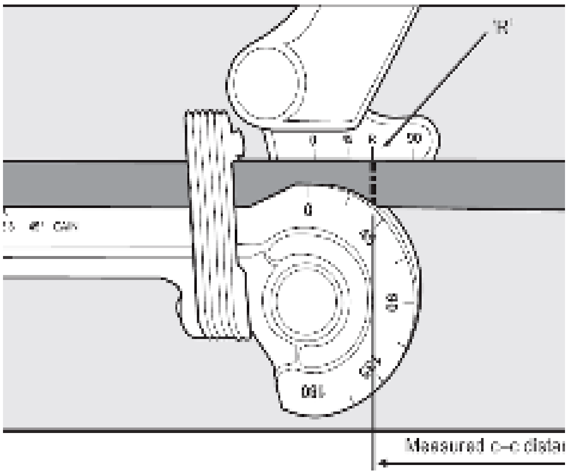


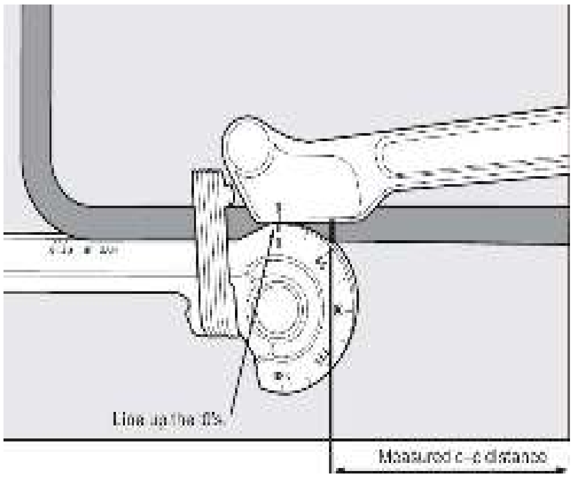



Rotate the handle until the ‘0’ and ‘90°’ line up (or the ‘45°’ mark were aligned if you were making that angle).
from the bender and check the

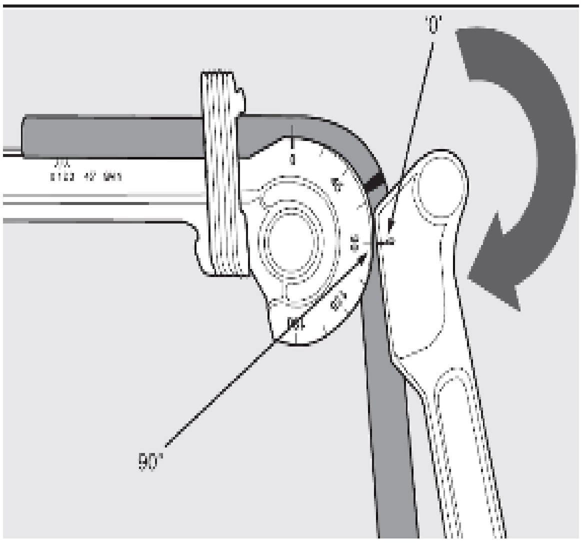
Remove the tube from the bender and cheek for squareness and to ensure there are no wrinkles or flattening of the bend.

When the measured distance is taken from the **right-hand side**, align the mark with the ‘R’, as shown below. This is for both 45° and 90° bends.




Close the shoe handle so its ‘0’ lines up with the ‘0’ on the form handle.





Then rotate the handle until the required mark is reached.

Check your bends for squareness and ensure that the tube assembly lays flat on the table.

**Pipe and tube Cutting**

Tubing should be cut with a tubing cutter, when available. The tubing should be marked where it is to be cut and the cutter should be installed so the cutter wheel is over the mark and the cutting wheel can be seen from the top view of the pipe, as shown in Figure 19. The adjustment wheel or handle should be turned clockwise to force the cutter wheel against the copper. The cutter should be revolved around the tubing and turn the adjustment wheel 1/4 turn per rotation until the copper is cut through and separates.

Tubing may be cut with a hacksaw, although a tubing cutter is preferable. It is important to be careful to cut the tubing square if it is to be flared. A fine-toothed hacksaw blade, with 32 teeth per inch, should be used when cutting copper.

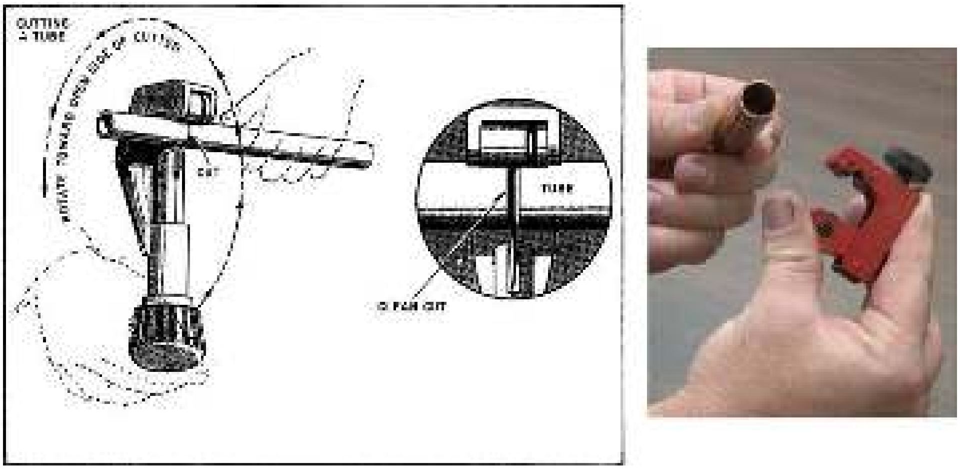



Figure 19 Tube cutter

Figure 20 Tube cutter

**The following steps should be taken when using a chip less cutter**:

1. Select the chip less cutter according to tubing size.
2. Rotate the cutter head to accept the tubing in the cutting position. Check that the cutter ratchet is operating freely and that the cutter wheel is clear of the cutter head opening (Figure 20).
3. Centre the tubing on two rollers and the cutting blade.

4. Use the hex key provided to turn the drive screw in until the cutter touches the tube.
5. Tighten the drive screw little. Do not over tighten the drive screw. Over tightening can damage soft tubing or cause excessive wear or breakage of the cutter wheel in hard tubing.
6. Swing the ratchet handle back and forth through the available clearance until there is a noticeable ease of rotation. Avoid putting side force on the cutter handle. Side force will cause the cutter wheel to break.
7. Tighten the drive screw an additional turn and swing the ratchet handle back and forth, retightening the drive screw as needed until the cut is completed.
8. The completed cut should be 1/2 degree square to the tube centreline.
9. After the tubing is cut, all burrs and sharp edges should be removed from inside and outside of the tube (Figure 18) with deburring tools. The tubing should be cleaned to make sure there are no foreign particles remaining. A convenient method for cutting tubing with a hacksaw is to place the tube in a flaring block and clamp the block in a vice. After cutting the tubing with a hacksaw, all saw marks should be removed by filing.

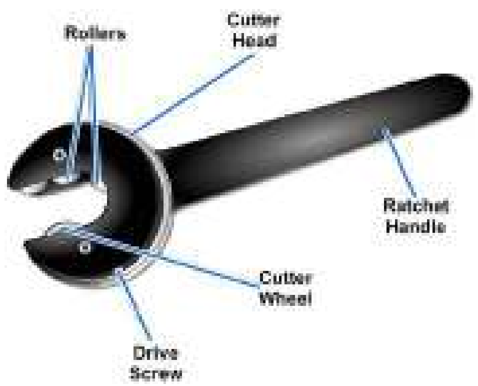



Figure 21 Chip less cutter.

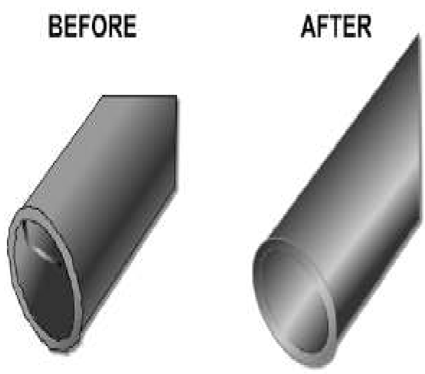
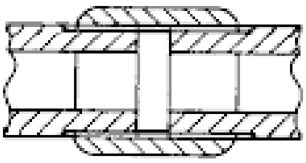
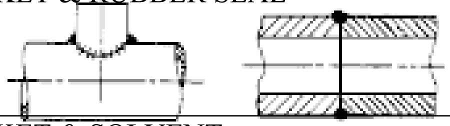
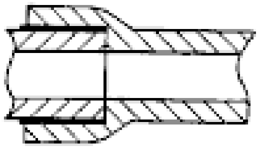
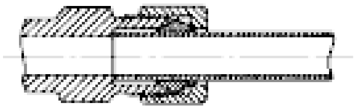
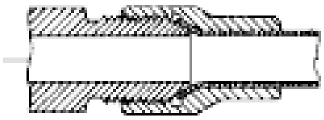
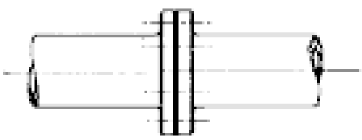



Figure 22 Properly burred tubing.

### 3.2.2 Joining Pipes

Table 6 illustrates a range of methods for joining pipes. The table indicates the form of the connection and the type of pipes on which the joint may be used.

Table 6 types of joining

| **TYPE OF JOINT** | **CHARACTERISTIC** |
|---|---|
| THREADED  | The jointing compound depends on the chemical characteristics of the fluid conveyed, the fluid temperature and whether the joint is permanent or has to be dismantled at a later date. Typically, a PTFE tape or fluid is used to assist sealing.<br>Mainly used for steel pipes, and for specialised plastic pipes |
| SOCKET & RUBBER SEAL  | Fusion is the use of welding for steel and aluminium pipes, brazing for copper pipes and hot gas for a plastic pipe.<br>A permanent fixture |
| SOCKET & SOLVENT  | Similar to fusion but mating of the two parts achieved by coating with a solvent cement<br>Used for plastic pipes. |
| COMPRESSION  | A sleeve or ferrule is placed over the pipe and, as the nut is tightened, the sleeve deforms slightly to retain the pipe |
| FLARED  | A special flaring tool is used to open out the end of the pipe, then the deformed pipe is retained in a special<br>Fitting. Widely used by plumbers for coupling to copper pipe |
| FLANGED  | The joint relies on a gasket between the parallel flanges to provide sealing, and bolts to maintain the seal pressure. The flanges may be welded to the pipe (steel, plastic) or be retained with a seal and separate bolts (concrete) The flange sizes and bolt diameter or pitches are made<br>to an Australian Standard so that they align with similar flanges on valves. Ideal for pipes that have to be occasionally separated |

**Tube Flaring**

Flaring is an easy and satisfactory method of joining copper tubing. The ends of the tubing should be flared and pressed against the tapered surface of the flared fitting. Next, the flare nut should be screwed over the end of the fitting.

An advantage of this type of connection is that it is easily disassembled when repairs are necessary. The only thing required to disassemble this connection is to select the correct size wrench, unscrew the flare nut that makes up the compression-type connection, and separate the fittings. When a flare is made on tubing, every precaution should be taken to produce an airtight and watertight joint. First, the tubing should be measured and cut to the proper length with a tubing cutter or hacksaw. Then, the burr within the tubing should be removed by reaming. Tubing can be flared with a flaring type tool (Figure 5-8).

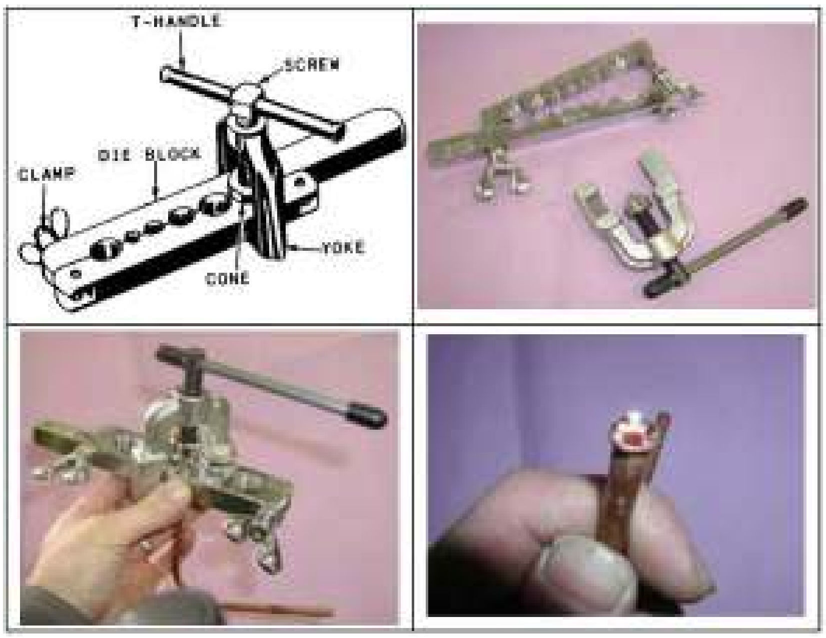



Figure 23 Flaring tool.

Before a flare is made, the flare nut should be slipped on the tubing and the end of the tubing inserted into the correct size hole in the flaring block. Then, the end of the tubing should be extended above the face of the block twice the wall thickness of the tubing.

Next, the flaring yoke should be attached to the flaring block and the flaring cone centered over the end of the tubing. The cone should be forced against the flaring block by rotating the handle on the flaring yoke clockwise. After the tubing has been flared properly, assembly of the joint is simple. After placing the flare against the fitting, the compression nut should be slipped against the flare and screwed on the fitting. This operation compresses the flare of the tubing between the fitting and nut. Figure 18: Flared-tube fittings.

Tees, crosses, and elbows are self-explanatory. Universal and bulkhead fittings can be mounted solidly with one outlet of the fitting extending through a bulkhead and the other outlet(s) positioned at any angle. Universal means the fitting can assume the angle required for the specific installation. Bulkhead means the fitting is long enough to pass through a bulkhead and is designed so it can be secured solidly to the bulkhead.

For connecting to tubing, the ends of the fittings are threaded with straight machine threads to correspond with the female threads of the nut. In some cases, however, one end of the fitting may be threaded with tapered pipe threads to fit threaded ports in pumps, valves, and other components.

Tubing used with flare connectors must be flared prior to assembly. The nut fits over the sleeve and when tightened, it draws the sleeve and tubing flare tightly against the male fitting to form a seal.

The male fitting has a cone-shaped surface with the same angle as the inside of the flare. The sleeve supports the tube so vibration does not concentrate at the edge of the flare, and distributes the shearing action over a wider area for added strength.

Correct and incorrect methods of installing flared-tube connectors are illustrated in Figure 19. Tubing nuts should be tightened with a torque wrench to the value specified in applicable technical publications.

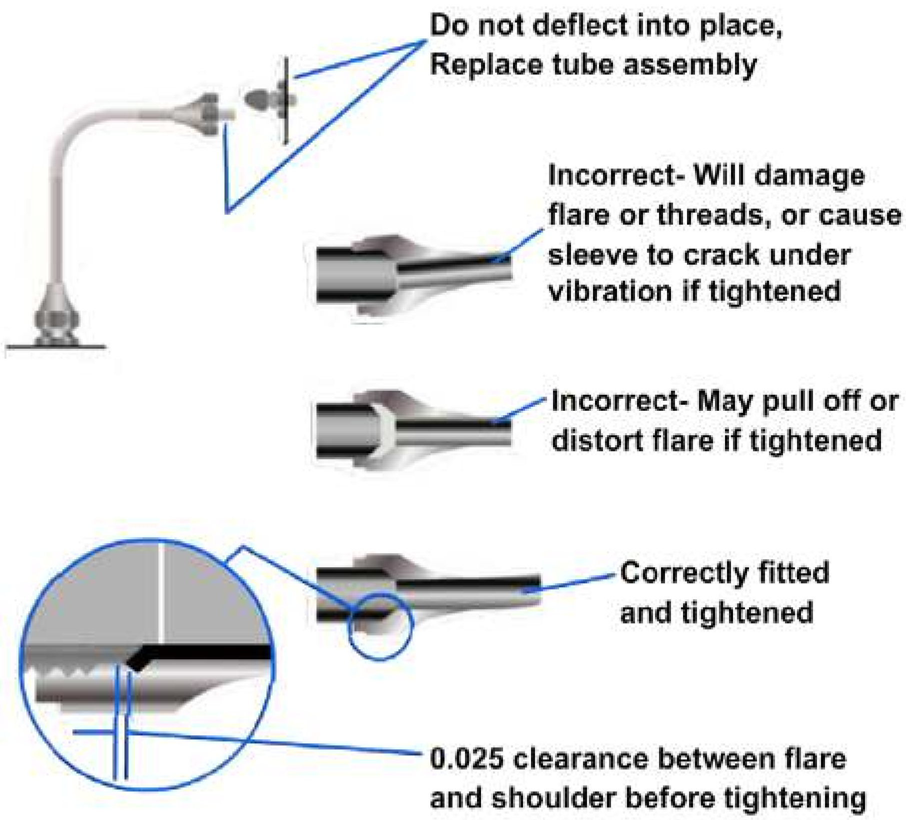



Figure 24 Correct and incorrect methods of installing flared fittings.

If an aluminium alloy flared connector leaks after being tightened to the required torque, it must not be tightened further. Over tightening may severely damage or completely cut off the tubing flare or may result in damage to the sleeve or nut. The leaking connection must be disassembled and the fault corrected.

If a steel tube connection leaks, it may be tightened 1/6 turn beyond the specified torque in an attempt to stop the leakage; then if it still leaks, it must be disassembled and repaired.

Under tightening of connections may be serious, as this can allow the tubing to leak at the connector because of insufficient grip on the flare by the sleeve. The use of a torque wrench will prevent under tightening.

### 3.4 Conduct Repair

#### 3.4.1Repairing copper tube

Copper pipes are connected with soldered, compression, or flare fittings. Always follow your local code for the correct types of pipes and fittings allowed in your area. Soldered fittings, also called sweat fittings, often are used to join copper pipes. Correctly soldered fittings are strong and trouble free. Copper pipe can also be joined with compression fittings or flare fittings. For repair leak copper tube or pipes follow the following step.

***A. Prepare tools and material before repairing the leak part***

**Specialty tools and materials for working with copper include**:

(A), flaring tools (B), emery cloth coil-spring (C),tubing bender (D), pipe joint compound soldering(E),paste (flux) (F), lead-free solder wire brush (G), flux brush (H), compression fitting (I), flare fitting (J

**B.** ***Identify the diameter and wall thickness using Grade stamp information sheet*** (*this sheet includes the pipe diameter, the wall-thickness grade, and a stamp of approval from the ASTM (American Society for Testing and Materials*).

### *C. Cut out the damaged pipe*

Shut off the main water supply valve, drain the damaged water line and use a pipe cutter to cut out a section of pipe that extends about 1 in. to each side of the leak. Start by gripping the pipe firmly in the cutter’s jaws and tightening the cutter’s screw. Rotate the cutter in the direction shown—as you tighten the screw handle—until the pipe snaps.


Figure 25 Cut out the damaged section

Bend flexible copper pipe with a coil-spring tubing bender to avoid kinks. Select a bender that matches the outside diameter of the pipe. Slip bender over pipe using a twisting motion. Bend pipe slowly until it reaches the correct angle, but not more than 90º.Cut out the damaged section, then measure the gap and, from the sweat coupling, cut a repair piece that’s 1 in.longer than the damaged section. Maybe if the change parts has shaped follow Figure 22.

Figure 26 Slip bender

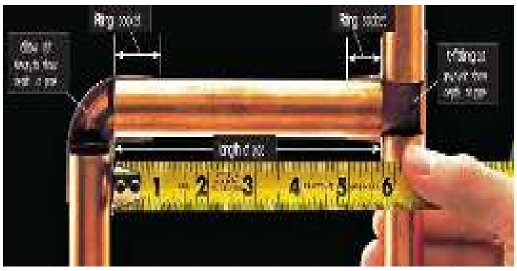
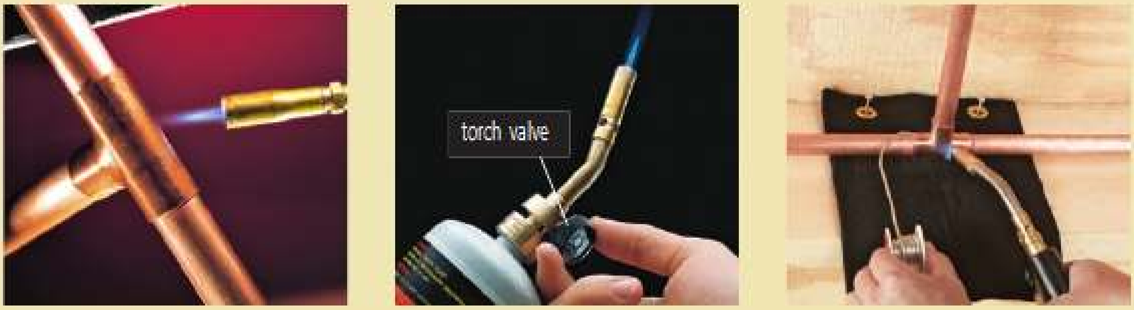


Figure 27 measuring

***D. Clean before soldering***

***F. Soldering:-*** A soldered pipe joint, also called a sweated joint, is made by heating a copper or brass fitting with a propane torch until the fitting is just hot enough tomelt metal solder. The heat draws the solder into the gap between the fitting and pipe to form a watertight seal. A fitting that is overheated or unevenly heated will not draw in solder. Copper pipes and fittings must be clean and dry to form a watertight seal.

tips for safe soldering




**Use caution** when soldering copper. Pipes and fittings become very hot and must be allowed to cool before handling.

**Prevent accidents** by shutting off propane torch immediately after use. Make sure valve is closed completely.

**Protect wood** from the heat of the torch flame while soldering. Use an old cookie sheet, two sheets of 26-gauge metal, or a fiber shield, as shown.

### 3.4.2 Repairing Hose

Most hose failures result from one of three causes: heat damage, chafing or improper installation and assembly. Failures from all three are preventable – if one knows what to look for.

**Heat damage** results from the hose resting against an exhaust-carrying component. No hose, whether fire-sleeved or not, will withstand direct contact with an exhaust stack. Such heat damage is usually not visible from the outside of the hose. At the point of contact, the hose liner overheats and becomes brittle (if rubber) or melts (if non-rubber). If the hose is moved or bent, a crack develops at the heat-damaged point.

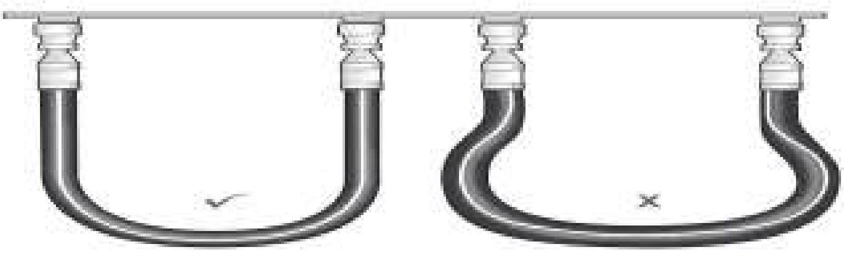
If you see a hose lying against a hot surface such as an exhaust, throw away the hose. You won't be able to see the damage but the hose liner, if it hasn't already failed, will not be far off doing so.

**Chafing** is a common cause of failure. It is almost never visible during a visual examination and therefore missed during most inspections. Think about it: the chafe point is where the hose rests against something – you can't see the chafe damage without moving the hose. Pull the hose away from any points of contact and look behind the hose. Wherever a hose is touching something you must inspect for chafing, cutting or other damage.

**Faulty installation:** hoses have a tendency to expand in diameter and contract in length when pressurised. When manufacturing and fitting hoses, this needs to be taken into consideration.


Use elbows to avoid sharp bends near the end of the hose assembly.


Maintain the minimum centreline bend radius




- Lines should normally be kept as short and free of bends as possible. However, tubing should not be assembled in a straight line, because a bend tends to eliminate strain by absorbing vibration and also compensates for thermal expansion and contraction. Bends are preferred to elbows, because bends cause less of a power loss. A few of the correct and incorrect methods of installing tubing are illustrated in Figure 5-1.

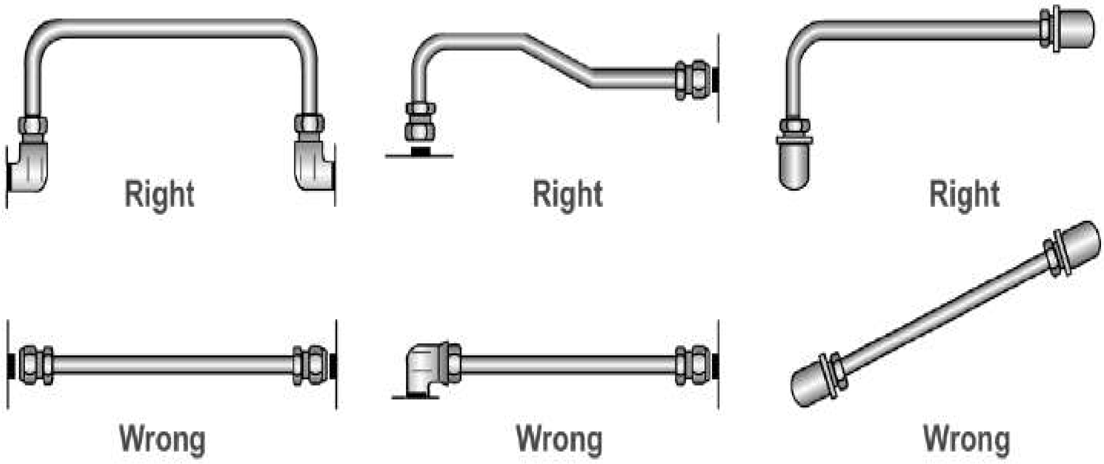



Figure 28 Correct and incorrect methods of installing tubing

- **Do not allow** hose movement in more than one plane. Flexing a hose in two separate planes of movement will cause torsion in the hose assembly. Always install the hose assembly so that flexing occurs in one plane only and this is the same plane in which bending occurs.

| Self-Check -3 | Written Test |
|---|---|

**PART-I:**

**Write "TRUE" if the statement is correct and "FALSE" if it is wrong statement.**

1. Sizing of Pipes are available in three different weights: standard.
2. Flaring is an easy and satisfactory method of joining copper tubing.
3. Hoses are used where there is a degree of movement between components.

**PART-II: Select the best answer from the given alternatives and write its letter on the space provided**

1. a soldered pipe joint, is called -------------?

A. a sweated joint
B. brass
C. Solder
D. All

2. ______________ is a common cause of failure

A. Chafing
B. Faulty
C. Perching
D. hose

3---------------- is an easy and satisfactory method of joining copper tubing

A. Flaring
B. fitting
C. space
D. Chafing

**PART-III: Match the items listed under column "A" with those expressions listed under "B"**

| **"Column A"** | **"Column B"** |
|---|---|
| _____1. Factors affecting incorrect installation of hose | A Sizing of Pipes |
| _____2. Use clamps and lacing to prevent hose from chafing | B reduced pressure |
| _____3. Place the in position using supporters | C Impact Testing |
| _____4. Available in three different weights and standard | D Soldering |
| _____5. A soldered pipe joint, also called a sweated joint Load or stress, it may fail | E. General hose installation principles |

## PART IV Sort answer

1. Explain, with the aid of sketches, three methods of joining two pipes together
2. Name and sketch three types of pipe fittings.
3. Describe four types of pipe used in engineering. Include typical properties and applications of each type.

## Operation 1

**Operation Sheet title: -** Prepare and set-up work

**Operation sheet purpose;-**cutting pipe and tube

**Instruction:-**Read the given drawing and cut in accordance with specifications and operational procedures

**Procurers**

**Step 1**- Read and understand work specification or working drawing

**Step 2**- Select the chip less cutter according to tubing size

**Step 3**- Consider OHS policy

**Step4**- Rotate the cutter head to accept the tubing in the cutting position.

**Step 5**- Centre the tubing on two rollers and the cutting blade.

**Step 6**- Use the hex key provided to turn the drive screw in until the cutter touches the tube.

**Step 7**- Tighten the drive screw little. Do not over tighten the drive screw.

**Step 8**- Swing the ratchet handle back and forth through the available clearance until there is a noticeable ease of rotation.

**Step9**- Tighten the drive screw an additional turn and swing the ratchet handle back and forth, retightening the drive screw as needed until the cut is completed.

**Step 10-** Tighten couplings and joints properly

**Step 11**- The completed cut should be 1/2 degree square to the tube centreline.

**Step 12**- After the tubing is cut; all burrs and sharp edges should be removed from inside and outside of the tube with deburring tools.

**Step 1**3- clean and return tools and equipment to their proper place

**Step 14** - clean work area

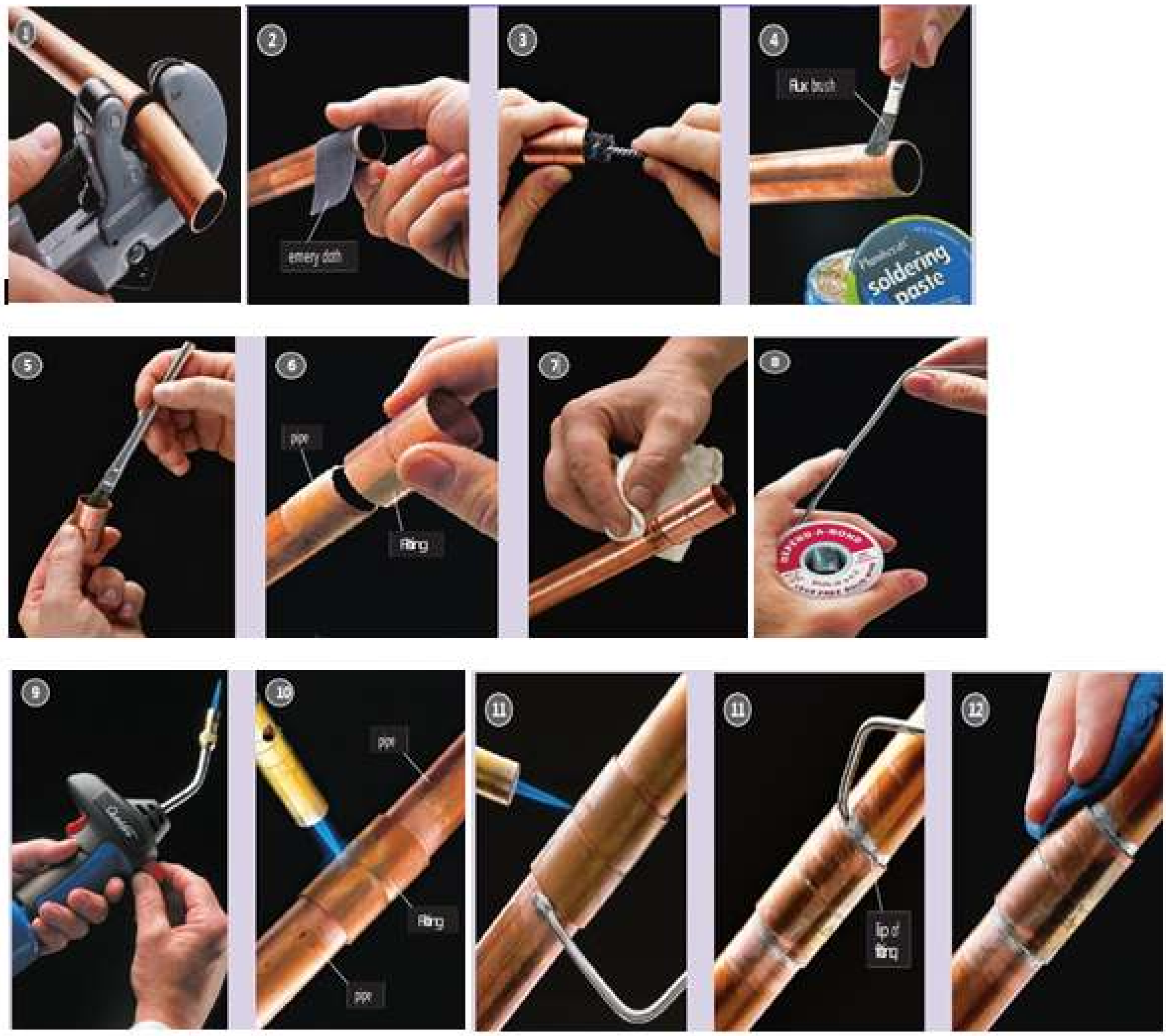
## Operation 2

**Operation Sheet title: -** permanent joining pipes

**Operation sheet purpose;-**soldering copper pipe

**Instruction:-**Read the understand the given drawing and soldering the copper tube in accordance with specifications and operational procedures

**Procurers**




| | |
|---|---|
| **tools & materials** | Tubing cutter with reaming, Lead-free solder |
| | Spark lighter ,Adjustable wrench ,Round file |
| | Copper pipe, Channel-type pliers ,Copper fittings |
| | Soldering paste (flux), Emery cloth, Rag, Lead-free solder, Wire brush |
| | |

## LAP test 1

**Task 1:** solder copper pipe

- Note diameter of 10mm
- Length 100mm( 2pic each)

## Unit Four: Assure quality and cleanup work

This unit to provide you the necessary information regarding the following content coverage and topics:

- Flush and pressure testing components
- Complete Test reports
- Clean up Work area

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

- Identify Flushing and pressure testing components
- Complete Test reports
- Clear Work area, tools materials and equipment's

# 4. Assure quality and cleanup work

## 4.1Flushing and pressure testing components

### 4.2.1. Flushing

Pipe Flushing is a pre-commissioning activity. Piping and pipeline systems are flushed before commissioning the line or put into action. Pipeline or Pipe Flushing can be defined as the activity where a sufficient quantity of fluid is pumped through the piping or pipeline section with sufficient velocity to forcibly remove construction debris, dust, rust, mill scale, oil, grease, or any other kind of impurities. The section of piping or pipeline system requiring flushing is defined beforehand and then a detailed pipe flushing plan is made for execution.

Pipe flushing is usually done for pipes with sizes 10 inches or less. For larger pipes, the fluid quantity requirement becomes so large that it slowly becomes impractical. So, full bore pipe flushing is usually not done for pipes with size 12 inches or larger.

**Types of Pipe Flushing**

Depending on the fluid used for the operation, pipe flushing can be of two types:

1. Chemical/Water flushing and
2. Oil flushing

1.**Chemical flushing** is the most common method used to remove garbage elements from the piping and pipeline systems using plain water and water with chemicals. On the other hand, oil flushing is carried out after chemical flushing to ensure the fluid that will flow through the pipelines are free from any kind of contamination.

2.**Oil flushing** is used for lube oil systems.

**Working Principle of Pipe Flushing**

Pipe flushing removes the unnecessary elements from the piping system by the force of flushing fluid which passes through the system at high velocity. The force applies on the foreign elements and becomes loose which then flows along with the flushing fluid making the pipe and pipeline surface clean.

**Basic Pipe Flushing Guidelines**

Some of the considerable pipe flushing guidelines are listed below:

- Detailed flushing plan should instruct about types, steps, and duration of flushing.
- Pipe flushing should be done using normal operation flow direction.
- Pipeline flushing should preferably be done from the highest to the lowest elevation.
- The pipe flushing activity should be supervised and inspected by a commissioning engineer.
- Flushing should be performed through fully open flanges/ open pipe ends and never be carried out through smaller openings such as drains or vents.
- The proper capacity of the pump shall be selected for pipe flushing activity.
- All required temporary fittings like a hose, blind flange, strainer, gasket, etc must be fitted before flushing and shall be removed immediately after completion of pipe flushing.
- To avoid corrosion potential, the system shall be de-watered immediately after flushing and make it dry.

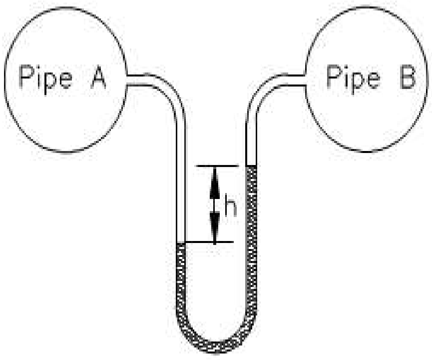
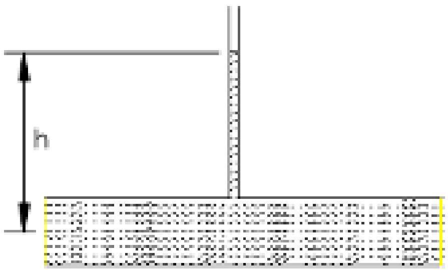
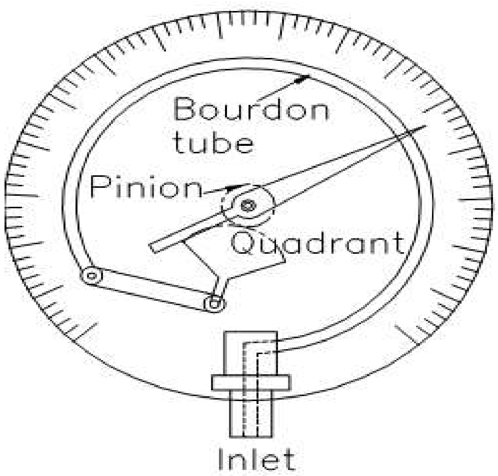
### 4.2.3 Pressure testing components

For safe and efficient operation, fluid power systems are designed to operate at a specific pressure and/or temperature, or within a pressure and/or temperature range.

Most fluid power systems are provided with pressure gauges and thermometers for measuring and indicating the pressure and/or the temperature in the system. Additionally, various temperature and pressure switches are used to warn of an adverse pressure or temperature condition. Some switches will even shut the system off when an adverse condition occurs.

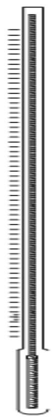
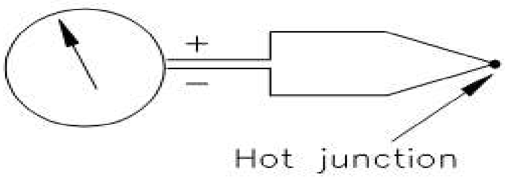
A range of instruments is used to measure fluid systems, for such variables as pressure, temperature and flow. The following equipment is a sample of the type of instruments found in industry, rather than in a laboratory setting.

**Pressure Gauges**

| | |
|---|---|
| MANOMETER   | Pressure in pipes A and B act on the fluid in the U-tube, such that the resultant elevation (h) is an indication of the difference in pressures between A and B. By combining the elevation (h) with the manometer fluid's density, the pressure difference may be calculated. If one side of the manometer is open to the atmospheric pressure, then (h) represents the gauge pressure in one pipe.<br>Typical fluids used are coloured water, kerosene and mercury (for higher pressures) |
| PIEZOMETER   | A piezometer may be likened to a leak in a garden hose - a jet of water rises to an elevation equivalent to the pressure in the hose.<br><br>The height (h) may be measured and used in conjunction with the density of the pipe' fluid to indicate pipe pressure. For accurate operation, the piezometer tube height must be measured vertically and be at a right angle to the fluid flow. |
| BOURDON TUBE GAUGE   | The Bourdon tube has an elliptical cross-section that deforms when GAUGE pressurised internally. Tube deflection is transmitted via a gear quadrant to an indicating needle. A negative pressure (vacuum) cause reverse operation, or for a vacuum gauge the mechanism linkage is reversed. The tube is made of steel (high pressures) or bronze.<br><br>For accuracy, a gauge should only be used for the middle 80% of its scale range. |

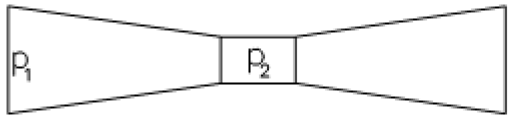
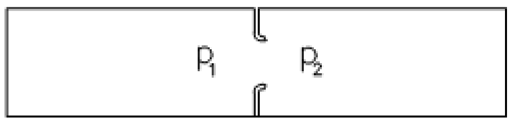
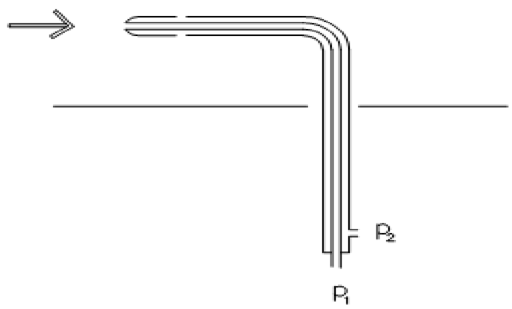
**Temperature Measuring Devices**

Temperature is one of the basic engineering variables. Therefore, temperature measurement is essential to the proper operation of a shipboard engineering plant. As a watch slander, you will use both mechanical and electrical instruments to monitor temperature levels. You will frequently be called on to measure the temperature of steam, water, fuel, lubricating oil, and other vital fluids. In many cases, you will enter the results of measurements in engineering logs and records.

| | |
|---|---|
| MERCURY THERMOMETER  | A glass capillary tube has a thin-walled reservoir at its base. The bulb is filled with mercury and as the temperature rises, the mercury expands and rises in the capillary tube. Graduations on or near the tube allow the temperature to be assessed. As mercury has a boiling point above 350°C and a freezing point<br><br>below -35°C, this type of thermometer has a range that is adequate for most industrial purposes. For a lesser temperature range (-100°C to +70°C) and cheaper construction, coloured alcohol is used instead of mercury. |
| THERMOCOUPLE   | Dissimilar metals, such as copper and constantan (40% nickel and 60% copper) are welded together at the `hot junction'. If the junction is heated, a small voltage is generated. The voltage may be directly related to temperature. By the use of suitable wires for the junction, temperatures up to 1650°C may be measured. |

**FLOW**

| | |
|---|---|
| VENTURI METER | Fluid flow passes through a convergent divergent pipe. As the fluid velocity increases at the smaller diameter (the throat) so the pressure in the fluid decreases. By measuring the pressure at the entry p1 and the throat p2, the flow may be |

| | |
|---|---|
|  | calculated. Some losses occur, but because of the gradual change in diameter, a venture<br><br>meter is about 97% efficient. A venture is useful where the fluid flow contains suspended solids.<br><br>A venture may also be placed in an open channel, where the same changes in velocity occur, but as the pressure cannot be measured the change of fluid elevation is used to calculate the flow. The venture principle is used in a carburettor, to draw fuel into the engine air flow. |
| ORIFICE METER<br> | A smooth-edged orifice is placed in a pipe carrying fluid flow. A pressure drop occurs across the orifice, and the flow may be calculated from the pressure drop and the orifice diameter. The orifice is made to a Standard, so its operating characteristics may be predicted.<br><br>An orifice meter is about 60% efficient, but is simple to construct and install. |
|  | The pitot tube is composed of two concentric tubes. Flow impacts on the end of the inner tube and the total pressure in the pipe or duct (velocity pressure plus static pressure) is measured at p1 . The static pressure in the pipe or duct is sampled through holes in the side of the outer tube and measured at p2. By the use of a manometer or differential pressure gauge, the value of p2 may be deducted from p1 and the velocity pressure determined.<br><br>Because the velocity near the walls of a duct is less than at the centre, several readings are taken across the duct (a traverse) and the average taken. Pitot tubes are manufactured to a Standard and are about 98% efficient. Mainly used for measuring the velocity in a ventilation or extraction duct. |

## Pressure Switches

It is often desirable to have an alarm sound a warning, a light give a signal, or an auxiliary control system energize or de-energize when a measured pressure reaches a certain minimum or maximum value. A pressure switch is the device commonly used for this purpose.

One of the simplest pressure switches is the single-pole, single-throw, quick-acting type shown in Figure 25. This switch is contained in a metal case that has a removable cover, an electrical connection, and a pressure-sensing connection. The switch contains a seamless metallic bellows located in its housing. Changes in the measured pressure cause the bellows to work against an adjustable spring. This spring determines the pressure required to actuate the switch. Through suitable linkage, the spring causes the contacts to open or close the electrical circuit automatically when the operating pressure falls below or rises above a specified value. A permanent magnet in the switch mechanism provides a positive snap on both the opening and closing of the contacts. The switch is constantly energized. However, it is the closing of the contacts that energizes the entire electrical circuit.

Another pressure switch is an electro hydraulic assembly that is used for shutting off the pump's motor whenever the system pressure exceeds a pre-determined maximum value (Figure 25-26). The switch is mounted on the pump housing so that the former's low pressure ports drain directly into the pump housing.

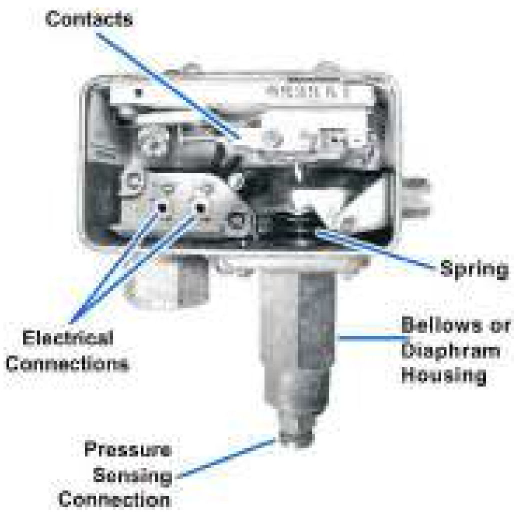


Figure 29 pressure switch

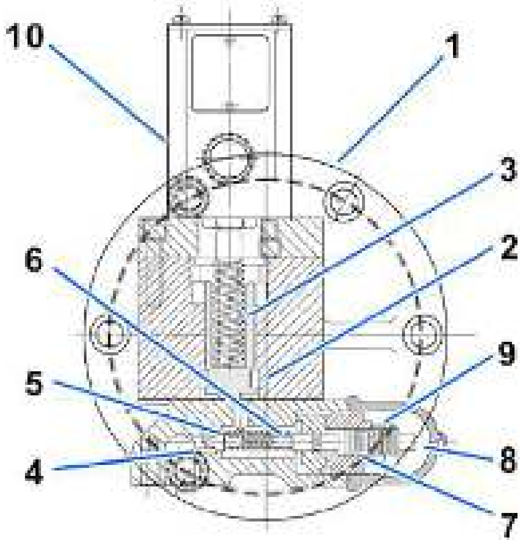



Figure 30 Electro hydraulic pressure switch.

This pressure switch principally consists of a flange-mounted hydraulic valve to which is fixed a normally closed electrical limit switch. The valve consists of two hydraulically interconnected components. The pilot valve subassembly, which bolts on the bottom of the body (1), functions to sense system pressure continuously, and initiates pressure switch action whenever this pressure exceeds the adjusted setting of the pilot adjustment. System pressure is directed into the bottom port and is applied against the exposed tip of the pilot piston (5). This piston is held on its seat by compression from the piston spring (6) which is dependent on the position of the adjusting screw (8). Whenever the pressure causes a force large enough to raise the pilot piston from its seat, fluid flows through an interconnecting passage to the actuating piston (2) chamber. The accompanying fluid force raises the actuating piston against the force of spring (3) and causes depression of the extended switch plunger. This action disconnects the contained electrical switch, which may be connected into the pump motor's electric supply system. Pressure switches come in many sizes and configurations depending on how they will be used.

## 4.2 Completing Test reports

After testing all components and system you should record and report your findings by organizing them in a format given below this format is an example but different company may use different format and procedures

| | | |
|---|---|---|
| Pressure test record No: | Pressure test plan No: | Pressure system ID: |
| Test parameters | | |
| Type of test pneumatic _______ | Hydraulic _______ | |
| Required test pressure: | Test fluid | Actual test fluid temperature: |
| Test starting time: | Test ending time: | |
| Test duration (starting - ending time); | Actual holding time: | |
| Test equipment –pressure gauge | | |
| Type | Pressure range : | Calibration date: |
| Actual test pressure | | |
| Environmental control | | |
| Exclusion zone for safety of people (actual safe distance) | | |
| Test area controls | Actual disposal of test fluid | |
| Results | | |
| Inspection | satisfactory _____ | not satisfactory (explain) |
| Pressure test | satisfactory _____ | not satisfactory (explain) |
| Remarks :- | | |
| Mechanic performing test (point) | Signature | Date |
| Inspector witnessing test( point) | Signature | Date |

### 4.3 Cleanup Work area, tools materials and equipment’s

#### 4.3.1 Cleaning work area

Cleaning your work area makes it a safe and pleasant environment for your customers to shop. The cleaning of your work area must be carried out on a regular basis. The quick and easy jobs can be carried out during the day, while other larger tasks such as vacuuming might be done before the shop opens, or at the end of the day's trading. In some larger retail stores, professional cleaners may be used for the larger tasks, but it is still your responsibility to keep your own work area clean and tidy.

In this activity you will learn about cleaning procedures and how to dispose of waste correctly. You will also learn how to handle spills or other potential hazards efficiently to protect customers and your workmates from potential injury.

**Poor housekeeping can be a cause of incidents, such as:**

A. tripping over loose objects on floors, stairs and platforms
B. being hit by falling objects
C. slipping on greasy, wet or dirty surfaces
D. striking against projecting, poorly stacked items or misplaced material
E. cutting, puncturing, or tearing the skin of hands or other parts of the body on projecting nails, wire or steel strapping

To avoid these hazards, a workplace must "maintain" order throughout a workday. Although this effort requires a great deal of management and planning, the benefits are many.

**Effective housekeeping results in:**

A. reduced handling to ease the flow of materials
B. fewer tripping and slipping incidents in clutter-free and spill-free work areas
C. decreased fire hazards
D. lower worker exposures to hazardous products (e.g. dusts, vapours)
F. better control of tools and materials, including inventory and supplies
G. more efficient equipment cleanup and maintenance
H. better hygienic conditions leading to improved health
I. more effective use of space
J. reduced property damage by improving preventive maintenance
K. less janitorial work

L. improved morale
M. improved productivity (tools and materials will be easy to find)

The fabrication, installation, and maintenance of all fluid lines and connectors are beyond the scope of this training manual. However, there are some general precautionary measures that apply to the maintenance of all fluid lines.

Regardless of the type of lines or connectors used to make up a fluid power system, they must be the correct size and strength and perfectly clean on the inside. All lines must be absolutely clean and free from scale and other foreign matter. Iron or steel pipes, tubing, and fittings can be cleaned with a boiler tube wire brush or with commercial pipe cleaning apparatus. Rust and scale can be removed from short, straight pieces by sandblasting, provided there is no danger that sand particles will remain lodged in blind holes or pockets after the piece is flushed. In the case of long pieces or pieces bent to complex shapes, rust and scale can be removed by pickling (cleaning metal in a chemical bath). Parts must be degreased prior to pickling. The manufacturer of the parts should provide complete pickling instructions.

Open ends of pipes, tubing, hose, and fittings should be capped or plugged when they are to be stored for any considerable period. Rags or waste must not be used for this purpose, because they deposit harmful lint which can cause severe damage to the fluid power system.

## Self cheek -4

**PART-I: Write "TRUE" if the statement is correct and "FALSE" if it is wrong statement.**

1. Cleaning your work area makes it a safe and pleasant environment
2. Temperature is one of the basic engineering variables
3. Pressure Switches It is often desirable to have an alarm sound a warning
4. Pipe flushing should be done using reveres operation flow direction
5. The proper capacity of the pump shall be selected for pipe flushing activity

**PART-II: Match the items listed under column "A" with those expressions listed under "B"**

| **"Column A"** | **"Column B"** |
|---|---|
| ______1. Effective housekeeping results in | A. more effective use of space |
| _____2. Cleaning your work area | B. a safe environment for your |
| _____3 is one of the basic engineering variables | C. Temperature |
| ____ 4. Advice measure by temperature | D Manometer |
| ____ 5. Advice Measure by Pressure | E Thermocouple |

**PART-III: Select the best answer from the given alternatives and write its letter on the space provided**

1. Poor housekeeping can be a cause of incidents, such as
   A. being hit by falling objects
   B. decreased fire hazards
   C. A&B
   D. ALL
2. It is often desirable to have an alarm sound a warning
   A. Pressure Switches
   B. temperature
   C. less janitorial work
   D. Measuring
3. A type of temperature measuring device a glass capillary tube has a thin-walled reservoir at its base.
   A. Orifice Meter
   B. Thermocouple
   C. Venturi Meter
   D. Bourdon tube