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सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
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WATER
MANAGEMENT
AND PLUMBING
SKILL COUNCIL

Participant Handbook

Sector
Plumbing

Sub-Sector
Industrial / Non-Industrial Plumbing

Occupation
Plumbing Systems Installation and Maintenance

Reference ID: **PSC/Q0104, Version-4.0**
NSQF Level: 4

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Plumber-General

Published by

Water Management and Plumbing Skill Council

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"Skilling is building a better India. If we have to move India towards development then Skill Development should be our mission."

Shri Narendra Modi
Prime Minister of India

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Certificate

COMPLIANCE TO QUALIFICATION PACK – NATIONAL OCCUPATIONAL STANDARDS

is hereby issued by the

WATER MANAGEMENT AND PLUMBING SKILL COUNCIL OF INDIA

for

Plumber General - PARTICIPANT HANDBOOK

Complying to National Occupational Standards of
Job Role/Qualification Pack: **Plumber-General** QP **NSQF PSC/Q0104 Level 3.0**

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Authorised Signatory
(Skilling India In Electronics)

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Without their contribution, it could not have been completed. Special thanks are extended to those who collaborated in the preparation of its different modules and thanks to those who have contributed a tremendous role to translate it from the English language to the Hindi language also. Sincere appreciation is also extended to all who provided peer reviews for these modules.

The preparation of this manual would not have been possible without the water management and plumbing industries' support. Plumbing industries' feedback has been extremely encouraging from inception to conclusion and it is with their input that we have tried to bridge the skill gap existing today in the industries.

Finally, we would like to express our gratitude to our master trainers, trainers and water management and plumbing skill council's management as they provided us with their valuable input to complete this "Participant Handbook".

About this Book

The basic idea for the preparation of this book has come from the challenges faced by the trainers during the skilling of trainees who are learning the skill through the trainers.
The information contained herein has been obtained from reliable sources of the water management and plumbing skill council (WMPSC). The water management and plumbing skill council disclaim all warranties to the accuracy, completeness or adequacy of such information. Water management and plumbing skill council shall have no liability for error, omission and inadequacy, in the information contained herein or for the interpretation thereof. Every effort has been made to trace the written material included in this book.
The water management and plumbing skill council faced so many challenges to complete the participant book, which required collecting information about every assembly, Indian standard of measurement and new technology initiated by the industry.
We have also faced challenges to incorporate the diagrams, design and practical layout of the installation of the fixtures and other water management amenities.

The Participant Handbook is designed based on the National Skill Qualification Framework (NSQF) aligned Qualification Pack (QP) and it comprises of the following National Occupation Stand rads (NOS)/ topics:

1.PSC/N0130 : Prepare for Plumbing Installations and Maintenance

2.PSC/N0131 : Install Water Supply Systems

3.PSC/N0132: Install Drainage Systems

4.PSC/N0133: Install Plumbing Fixtures

5.PSC/N0142: Perform Troubleshooting and Maintenance for Domestic Plumbing Fixtures and Systems

6.PSC/N0136: Apply Health and Safety Practices at the Workplace

7. PSC/N0137: Work Effectively with Others

8. DGT/VSQ/N0102: Employability Skills (60 Hours)

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1. Introduction to the sector and the job role

WATER MANAGEMENT AND PLUMBING SKILL COUNCIL

Unit 1.1 - Plumbing Industry-An Introduction

Unit 1.2 - Water Flow Process

PSC/N0130

Key Learning Outcomes

At the end of this module, the trainee will be able to:

1. Explain the importance of plumbing industry
2. Describe the key responsibilities of an assistant plumber general

UNIT 1.1 - Plumbing Industry-An Introduction

Unit Objectives

At the end of this Unit the trainee will be able to:

1. Outline the overview of the plumbing industry
2. List the common types of plumbing systems that are installed in residential setups
3. Discuss the scope of employment in the contracting segment of the industry
4. List the key responsibilities of an assistant plumber general

1.1.1 Overview of the Plumbing Industry

As India's real estate market continues to expand people are spending more money on bathroom fixtures and luxuries than on their living rooms. Today, the pipes and fittings industry is crucial to ensuring the ethical and safe use of water. Irrigation, sanitation, and building have seen an increase in demand for plastic pipes; these industries have emerged as major contributors to the market's quick expansion in India. According to Technopak Advisors Pvt Ltd, a Delhi-based retail consultancy firm the luxury home decor market is expanding at a rate of 25% per year and is predicted to reach $2 billion by 2015. With more complicated structures being developed and built, there is an increasing demand for trained plumbers. A National Skill Development Council study found that only 0.5% of plumbers in this country are properly trained. There will be a huge need for 12 lakh trained plumbers in the future but presently only 2.5 lakh and the majority of them are untrained or self-taught.

India is predicted to have substantial growth over the next few years on the back of expanding urbanization, rising infrastructure development, and the government's push for infrastructural growth. Between FY 2018 and FY 2026, the pipes and plastic fittings industry is anticipated to have a CAGR of 14%. Favorable legislative environments and citizen-focused efforts, such as the implementation of "Housing for All" programs and the goal of increasing farmer income through improved infrastructure, are among the main drivers of the sector's expansion. The identification of fresher uses for CPVC and the expansion of UPVC pipes into new markets have also turned out to be helpful accelerators. The domestic plastic pipe market is expected to be worth Rs. 315 billion, with organized companies holding a 60% share of the market. Although the epidemic forced most industries to reassess how they conduct business, the building sector found itself with a rare chance to innovate and expand. As unorganized producers continue to lose market share, organized players have outpaced industry growth.

Future of the Plumbing Industry

Hands-free products will be widely used, particularly in public restrooms. Sensor-based parts would be the ideal option, for the commercial environment. Although practically all significant businesses have had to reevaluate how they conduct business as a result of the pandemic, the construction sector in particular offers a special chance to change and advance.

1.1.2 Scope of Employment in the Contracting Segment

The plumbing Industry in India faces a huge challenge of a skill gap between the availability and demand of skilled workers. Odisha's Kendrapara district has a greater number of plumbers in India but only 10 % are organized, and 90% of the total plumbers are from the unorganized sector. Most plumbers learn their work from their experience, they do not get any formal training. The plumbing industry is in desperate need of training that can spread the necessary information and help to meet the rising demand. The plumbing industry as a whole is mostly disorganized and depends on a contract workforce. Contractors, manufacturers, and consultants mostly work independently without proper knowledge of tools and safety practices.

Plumbers are trained through programs like the Pradhan Mantri Kaushal Vikas Yojana (PMKVY), DAY-NULM (Deendayal Antyodaya Yojana-National Urban Livelihoods Mission), and state-specific skill development programs. Women plumbers in India now have the chance to participate in IPSC training. Similar to this, brands like Truflo by Hindware are partnering with IPSC to release relevant training modules, as are educational/training institutions like the International Association of Plumbing and Mechanical Officials (IAPMO), Indian Institute of Plumbing (IIP), MKG Consultants, and Northern Sanitations P. Ltd. All India Council of Technical Education (AICTE) has signed a Memorandum of Understanding (MoU) with Indian Plumbing Education (IPA) in order to establish plumbing education in Engineering and Architecture schools across India. As per the recent data from the U.S. Bureau of Labor Statistics (BLS) the demand for services provided by the plumbing industry is anticipated to grow over the following 5 years.

1.1.3 Plumbing Industry Sub-Sectors

The services of plumbers are required in the following sectors:

- **Construction**
- **Fire Fighting**
- **Air-Conditioning**
- **Industrial Waste Management**
- **Gas Supply**
- **Sewage and Drainage**
- **Water Supply and Water Treatment**

Fig 1.1 Plumbing Sub Sectors

There are three main divisions in the plumbing industry:

I. Plumbing consultants

II. Manufacturers of Plumbing related products

III. Contractors and Plumbers in the construction industry

1.1.4 Key Responsibilities of a Plumber General

A plumber is responsible for Installing, maintaining, and repairing pipes in commercial buildings like apartment complexes or residential homes. They work along with other construction professionals such as general contractors to make sure everything goes as per the plan during renovations or new builds. Following are the major roles and responsibilities of a plumber:

- **Reading blueprints or drawing to plan installation**
- **Installing and maintaining water supply systems**
- **Installing and maintaining drainage system**
- **Installing plumbing fixtures**
- **Industrial Waste Management**
- **Fitting and repairing various household appliances**
- **Inspecting and Diagnosing plumbing system for safety**
- **Identifying and Resolving faults in domestic/commercial plumbing systems and fixtures**
- **Following health and safety practices at the workplace**
- **Handling customer queries**

Fig 1.2 Roles and responsibilities of a plumber

Since a plumber has a wide range of responsibilities, a diverse set of skills is beneficial in propelling them through the process. Let's look at the required skills or key competencies of a Plumber general

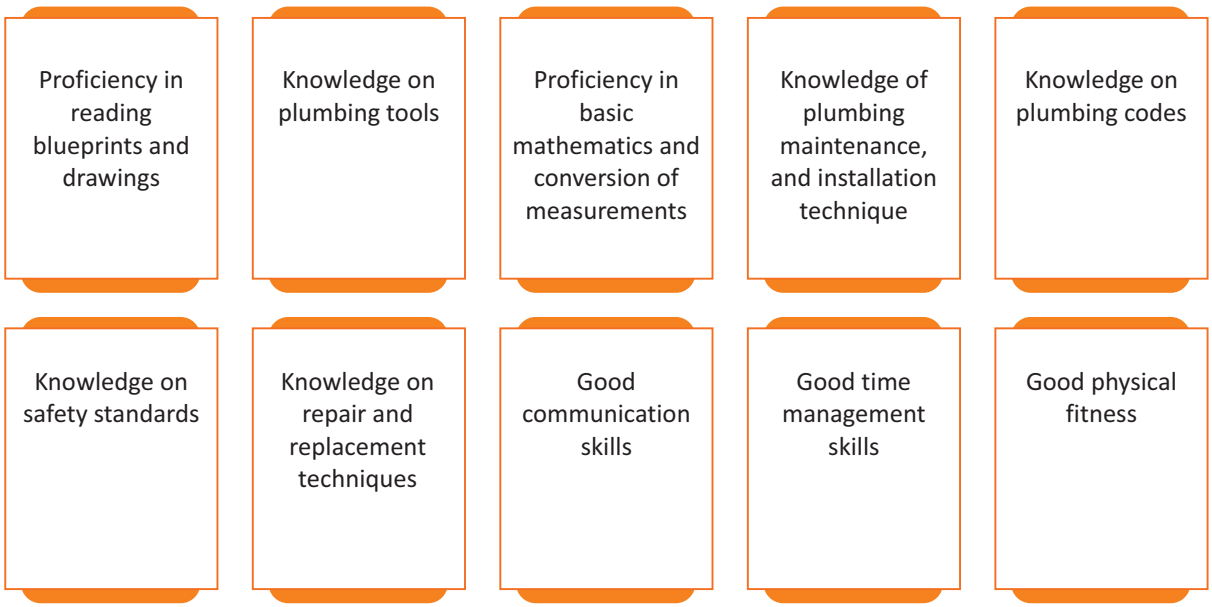

Fig 1.3 Key competencies of Plumber General

Notes

UNIT 1.2 - Water Flow Process

Unit Objectives

At the end of this Unit the trainee will be able to:

1. Describe the process of water flow in domestic households and commercial setups
2. Discuss the application of various types of plumbing systems in residential and commercial setups

1.2.1 Plumbing Cycle

A plumbing cycle is a system for collecting water from a source, distributing it to consumers, and then collecting and properly treating wastewater before returning it to the source. A typical plumbing cycle of domestic households and commercial setups is shown below:

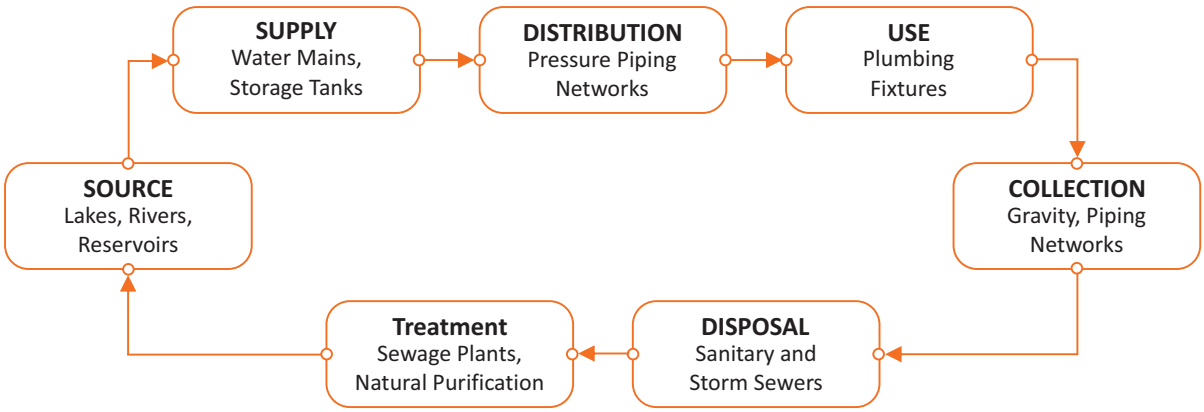

Fig 1.4 Plumbing Cycle

1. **Source**

   Lakes, Rivers, Open well and Reservoirs are the primary sources of water. Moreover, rainwater can be harvested and stored directly in storage tanks. Additionally, rainwater can be harvested and stored directly in storage tanks. After the first rain, this water can be used for drinking purposes.

2. **Supply**

   The water collected from the different sources will be supplied to households and commercial buildings through water mains and stored in storage tanks.

3. **Distribution**

   The stored water will be distributed down with gravity pressure for drinking and other purposes. The water storage tanks should be properly covered and protected from contamination.

4. **Use**

   Fresh water is delivered through water supply pipes from storage to sinks, toilets, washers, bathtubs, and related fixtures.

5. **Collection and Disposal**

   The wastewater system collects and disposes of the used water through the use of gravity. The used water is flushed into drain traps to stop the flow of noxious gases into the house. The wastewater is collected in the septic tank or the public sewer line after leaving the building through the wastewater mainline.

6. **Treatment**

   Wastewater treatment plays an important role in plumbing due to the rising water demand by people. It ensures the water released into local waterways, such as rivers, is safe and clean to prevent people's lives from harmful diseases. Several processes in the treatment process ensure the wastewater is clean and safe.

1.2.2 Water Flow Process

The process of water flow in domestic households and commercial setups is described below:

- Service reservoirs are situated on high land to allow water to be distributed to users by gravity through distribution mains. The water department pumps water into a water tower, which frequently stands on high elevations in the town, from a reservoir, river, or well as one method of supplying water to local residents.
- The water main in a building (3/4 inch or larger pipe), receives water from the city's main water line. This supply line enters your home directly from the ground and is buried deep enough beneath your property to prevent freezing.
- Branch and grid/loop are the two basic configurations for most water distribution systems. A branch system works similarly to a tree branch in that it allows water to travel only one path from the source to the consumer by branching tiny pipes off bigger pipes all across the service area.

Notes

1.2.3 Various Types of Plumbing Systems in Residential and Commercial Setups

Building plumbing systems consist of an underground tank that receives water from municipal or water department supply lines, an above tank that receives water from pumps and piping distribution systems, and residential outlets that receive water via gravity. Different types of plumbing systems are:

- **Sanitary drainage system**
- **Stormwater drainage system**
- **Potable water system**

Fig 1.5 Different types of plumbing systems

1. Sanitary Drainage

A drainage system (drainage piping) refers to all piping within public or private property that transports sewage, rainwater, or other liquid wastes to a legal point of disposal. The mains of a public sewer system and sewage treatment or disposal facilities are not included in a drainage system.

Fig 1.6 Sanitary Sewer System

Source: https://www.dreamstime.com/stock-illustration-sanitary-system-diagram-text-schematic-section-view-illustration-contemporary-sewer-depicting-residential-connection-image63622857

2. Storm Water Drainage System

You may have observed some little holes on the sidewalk which are known as storm drains. These are employed to transport extra water away from a building. The water that entered a storm drain used to drain into a sanitary drainage system in the old days. Moreover, they still do in some places. Rainwater is now, however, diverted to a storm drain. Gutters play an important role in draining rainwater. However, neglecting to maintain the gutters can result in significant problems. Following are the common signs of malfunctioning gutters:

- The paint starts peeling off the house
- The gutters are cracked
- The gutters are split
- Your home has sustained water damage

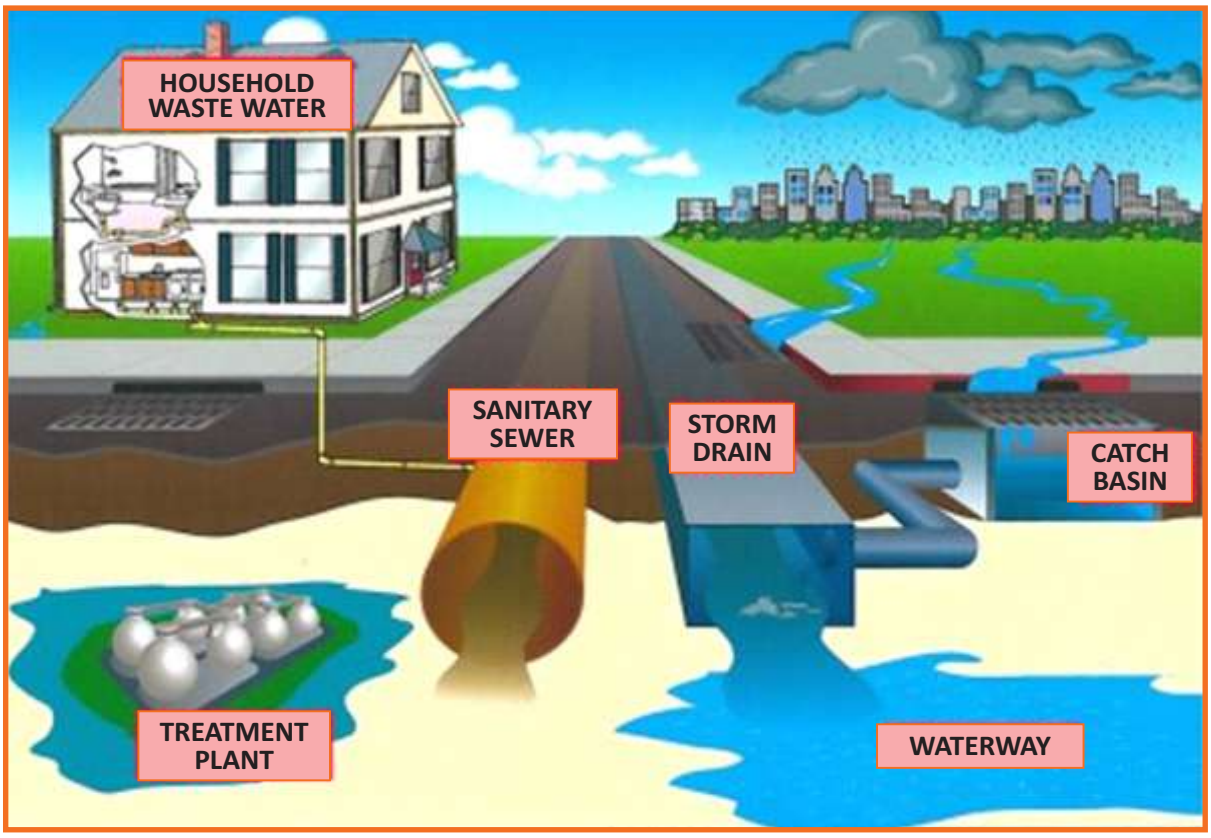

Fig 1.7 Stormwater Drainage System

Source: https://www.deeptrekker.com/resources/storm-water

3. Potable Water System

A potable water system is what enables people to use water within a building. A single system connects a number of different pipes that make up this system. This system has a valve that can be used to shut off the water supply. Additionally, a meter that displays the amount of water consumed throughout the facility is typically included.

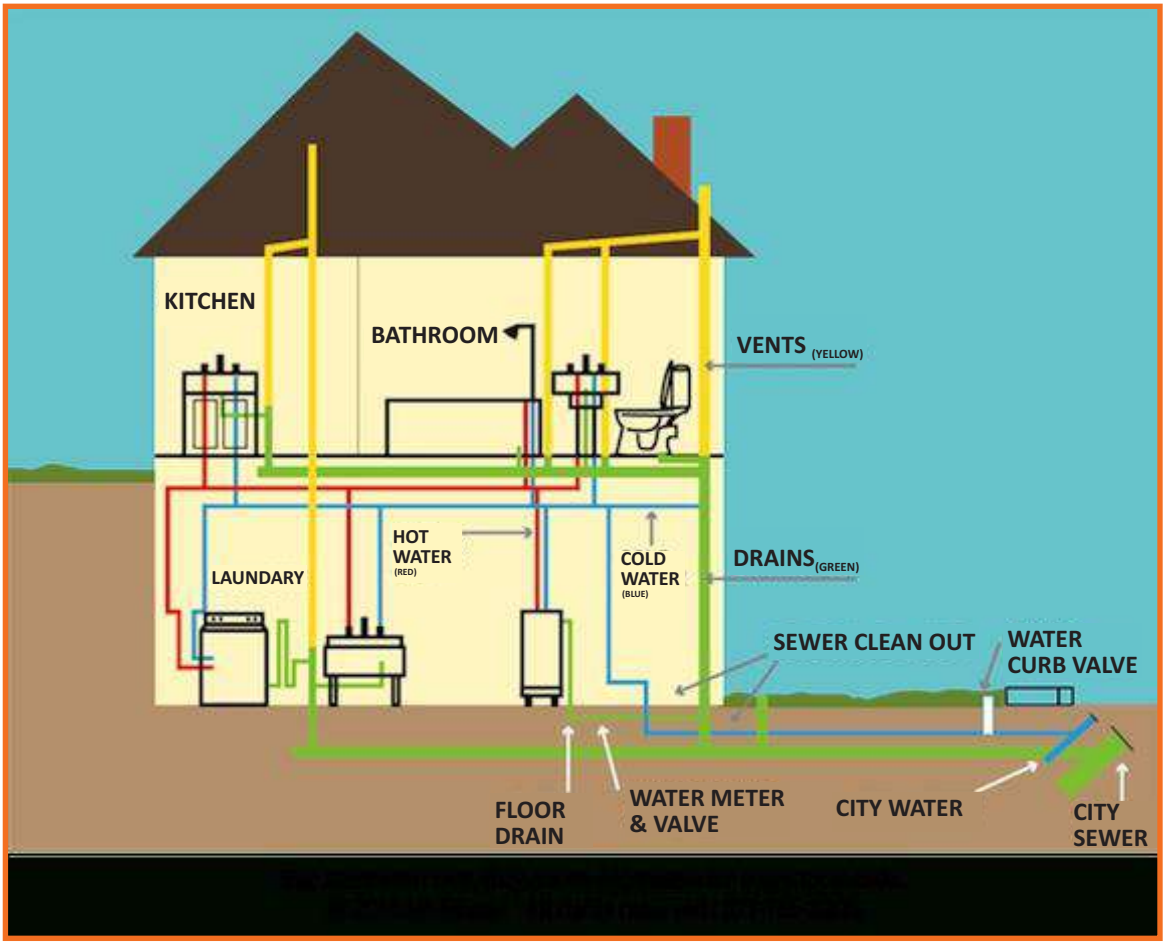

Fig 1.8 Potable Water System

Source: https://gharpedia.com/blog/residential-plumbing-system/

Notes

Summary

- Today, the pipes and fittings industry is crucial to ensuring the ethical and safe use of water. Irrigation, sanitation, and building have seen an increase in demand for plastic pipes; these industries have emerged as major contributors to the market's quick expansion in India.
- A National Skill Development Council study found that only 0.5% of plumbers in this country are properly trained.
- There will be a huge need for 12 lakh trained plumbers in the future but presently only 2.5 lakh and the majority of them are untrained or self-taught.
- India is predicted to have substantial growth over the next few years on the back of expanding urbanization, rising infrastructure development, and the government's push for infrastructural growth.
- Hands-free products will be widely used, particularly in public restrooms. Sensor-based parts would be the ideal option, for the commercial environment.
- The plumbing Industry in India faces a huge challenge of a skill gap between the availability and demand of skilled workers.
- Odisha's Kendrapara district has a greater number of plumbers in India but only 10 % are organized, and 90% of the total plumbers are from the unorganized sector.
- The plumbing industry is in desperate need of training that can spread the necessary information and help to meet the rising demand.
- Plumbers are trained through programs like the Pradhan Mantri Kaushal Vikas Yojana (PMKVY), DAY-NULM (Deendayal Antyodaya Yojana-National Urban Livelihoods Mission), and state-specific skill development programs.
- A plumbing cycle is a system for collecting water from a source, distributing it to consumers, and then collecting and properly treating wastewater before returning it to the source.
- A water distribution system is a component of the water supply network that transports potable water from a centralized treatment facility or wells to users to meet their needs for household use, business use, industrial use, and firefighting.
- Building plumbing systems consist of an underground tank that receives water from municipal or water department supply lines, an above tank that receives water from pumps and piping distribution systems, and residential outlets that receive water via gravity.

Exercise

Answer the following questions :

1. Write a brief note on the plumbing industry and its future.

2. List the roles and responsibilities of a plumber general.

3. Describe the plumbing cycle and its different stages.

4. Explain the process of water flow in domestic households and commercial setups.

5. Write a brief note on various types of plumbing systems in residential and commercial setups.

Notes

Notes

QR Code

Scan the QR Code to watch the related video

https://youtu.be/Rfz1zVu8VaQ
Overview of the Plumbing Industry

https://youtu.be/Fq7FIsuNCQI
Scope of Employment in the Contracting Segment

https://youtu.be/-bvZCdMecEo
Plumbing Cycle

https://youtu.be/8jxRn-T_LCs
Various Types of Plumbing Systems in Residential and Commercial Setups

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WATER MANAGEMENT AND PLUMBING SKILL COUNCIL

2. Basics of Plumbing

PSC/N0130

Key Learning Outcomes

At the en d of this module, the trainee will be able to:

1. Identify the various plumbing related systems, materials, tools and equipment
2. Summarize the common terms, symbols and jargon used in plumbing

Unit 2.1 - Introduction to Plumbing

Unit Objectives

At the end of this Unit the trainee will be able to:

1. Recall the various types of symbols and terminologies and titles used in plumbing installation
2. Describe the standards applicable (such as ISI) to piping installations in the plumbing industry
3. State the importance of accuracy in measurements and calculations with respect to plumbing work

2.1.1 Plumbing System

Plumbing is defined as a system of pipes and fixtures installed in a building used for supplying water and removing the used water and waterborne wastes. Every home and building must have a plumbing and sanitary system. The plumbing system must be planned and designed properly in order to meet the residents' needs for hygiene. According to reports, plumbing and sanitary work account for around 8% of a building's construction costs. The primary functions of a plumbing system are:

I. To provide a sufficient amount of potable hot and cold-water supply for a house's occupants.

II. To drain all sewage and wastewater from fixtures into a public sewer system.

Water is supplied from storage tanks to a home or building through pipes. Similar to that, pipes are used to drain out the wastewater from the kitchen and bathrooms. Plumbing and sanitary systems are necessary for any structure to operate correctly, whether it is residential, commercial, or industrial. Therefore, it is crucial to have a consistent and ample water supply as well as an appropriate method for disposing of wastewater. Plumbing and pipe-fittings play an important role in all types of building constructions. An effective plumbing system ensures greater sanitation and keeps the atmosphere free from bad smells. Any building should be constructed with an effective plumbing plan and general sanitation. The plumbing in many buildings has suffered as a result of inadequate consideration given to these factors, which has led to major difficulties for building occupants. A properly designed plumbing system helps to avoid the possibility of contamination of protected water.

Notes

2.1.2 Plumbing Symbols

A trained plumber does the installation of the fittings and fixtures as per the drawing provided in the assembly sheet of the plumbing fixture in the manufactures catalog. Identification of the symbol given in the drawing in the fixtures makes the installation work easy for a plumber. Different Plumbing symbols are listed below:

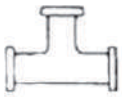
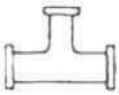
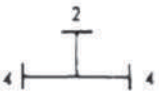
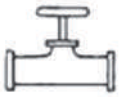
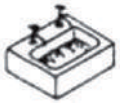
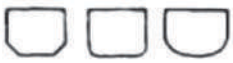
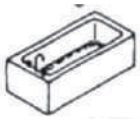
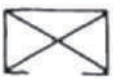
	ILLUSTRATED	SYMBOLS (THREADED)
90° ELBOWS		
STRAIGHT TEE		
REDUCING TEE		
SANITARY TEE		
P-TRAP		
GATE VALVE		
SHOWER HEAD		
LAVATORY (SINKS)		
BATH TUBS		
SHOWER STALL		

Fig 2.1 Plumbing Symbols

Source: https://www.pinterest.com/pin/566679565596238989/

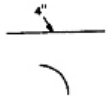
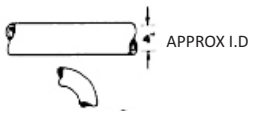
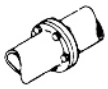
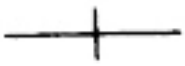
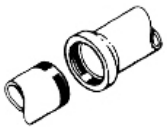
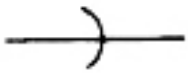
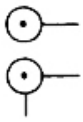
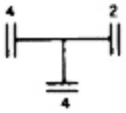
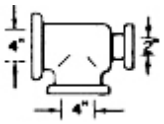
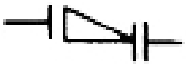
ITEM	SYMBOL	SAMPLE APPLICATION (S)	ILLUSTATION
PIPE	SINGLE LINE IN SHAPE OF PIPE USUALLY WITH NOMINAL SIZE NOTED		
JOINT- FLANGED	DOUBLE LINE		
SCREWED	SINGLE LINE		
BELL AND SPIGOT	CURVED LINE		
OUTLET TURNED UP	CIRCLE AND DOT		
OUTLET TURNED DOWN	SEMICIRCLE		
REDUCING OR ENLARGING FITTING	NORMAL SIZE NOTED AT JOINT		
REDUCER CONCENTRIC	TRIANGLE		
ECCENTRIC	TRINGLE		
UNION SCREWED	LINE		
FLANGED	LINE		

Fig 2.2 Plumbing Symbols

Source: https://www.pinterest.com/pin/566679565596238989/

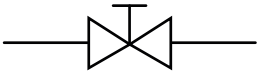
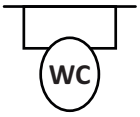
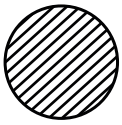
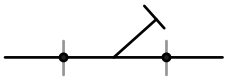
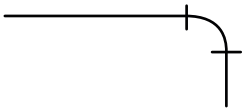
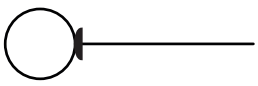
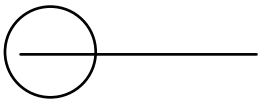
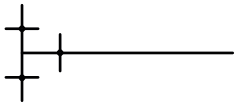
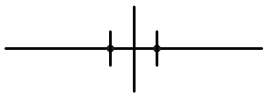
	WATER METER		COLD WATER
	HOT WATER		VENT LINE
	SANITARY WASTE		GAS PIPE
	GATE VALVE		WATER HEATER SHUT OFF
	WATER CLOSET		LAVATORY
	WATER HEATER		DISHWASHER
	CLOTHES WASHER		FLOOR DRAIN
	CLEAN OUT		VENT THRU ROOF
	90 DEGREE ELBOW		PIPE TURNS UP
	PIPE TURNS DOWN		TEE
	UNION		CAP

Fig 2.3 Plumbing Symbols

Source: https://www.pinterest.com/pin/566679565596238989/

2.1.3 Plumbing Terminologies

It is important to understand the basic terminologies used in plumbing. Understanding these words can assist the Plumber general to prepare and estimate their work as well as comprehend the plumbing fixture assembly page in the manufacturer's catalog. Some commonly used plumbing terminologies are listed below:

Plumbing Terminology	Description
Airgap	The distance between the lowest point of a water inlet or pipe to a tank and the overflowing level of the tank
AC pipes	Asbestos-Cement pipe used in water distribution systems
Appliance	a container or equipment where water is heated, treated, metered, or used before passing to waste
Auger	A tool having a rotating helical screw blade used for drilling a hole
Available head	The head of water available at the point of consideration due to main's pressure or overhead tank or any other source of pressure
Backflow	It is an unwanted flow of water in the reverse direction. It leads to wastage of water and it is due to leakage or defect in the system.
Backflow prevention device	It allows water to flow in one direction but never in the opposite direction. It also helps to prevent drinking water from being contaminated due to backflow
Back siphonage	The backflow of used, contaminated, or polluted water into a water supply pipe from a plumbing fixture or vessel as a result of lowered pressure in that line.
Bathroom vanity	The combination of the bathroom sinks or basin and the storage that surrounds it.
Bidet	It is a special plumbing device that enables someone to wash their inner buttocks, anus, and genitalia with water after using the restroom. In developed countries, these fittings are quite popular
Branch	Any part of the piping system other than a main pipe is known as branch
Branch Soil Waste Pipe (BSWP)	It is used to connect one or more soil appliances to the main soil pipe
Branch Ventilating Pipe (BVP)	A pipe, one end of which is connected to the system adjacent to the trap of an appliance and the other to a main ventilating pipe or a drain-ventilating pipe. It is fitted to prevent loss of water seal from a trap, owing to partial vacuum back pressure, or surging caused by air movement within the pipe system. It also provides ventilation for the branch waste pipe.

Continued...

Plumbing Terminology	Description
Branch Waste Pipe (BWP)	It is used to connect one or more waste appliances to the main waste pipe
Building drain	The building (house) drain is a component of a drainage system's lowest horizontal pipework that collects the drainage from soil, waste, and other drainage pipes located inside the structure's walls. Beginning one meter outside the building wall, it transports the discharge to the building (house) sewer.
Building sewer	The portion of the horizontal drainage system known as the building (house) sewer extends from the end of the building drain and collects the building drain's discharge before transporting it to a public sewer, a private sewer, a person's individual sewage-disposal system, or another point of disposal.
Burr	It is a raised edge or a little piece of material that is still attached to the workpiece after a modification operation. Deburring is the process of removing an undesired portion of material using a de-burring tool.
Cistern	It is a tank for storing water, especially one supplying taps or as part of a flushing toilet
Cleaning eye	It is referred to as an access eye or cleaning eye when a removable plug with a removable cover is installed into the pipe fitting as an eye opening and obstacles are removed through this opening.
Couplers	A pipe connector known as a coupler is used to unite two pieces of pipe that are either the same diameter or of different diameters. Depending on the need, a coupler's one end may have a larger or smaller diameter.
Crown of trap	The top-most point of the inside of a trap outlet.
Direct tap	A tap or faucet, which is connected to a supply pipe and subject to pressure from the water main
Down take tap or faucet	A tap or faucet connected to a system of piping, not subject to water pressure from the water main
Drain water outlet	Any pipe which conveys discharges from sanitary appliances in a drainage system.
Drain ventilating pipe (DVP)	It is a pipe that was installed to supply airflow to or from a drain in order to avoid an excessive concentration of sluggish air in the drain. Anywhere the main soil pipe or main waste pipe's higher portions, which do not receive discharges, are extended to roof level and left open to the air, they can be used as drain ventilating pipes.

Plumbing Terminology	Description
Dwelling	It is a structure that was made, built, or specifically designed with human habitation in mind. It might consist of garages, additional outhouses, etc.
Escutcheon	A flat piece of metal for protection and often ornamentation, around a keyhole, door handle, or light switch
Fitting	It refers to the plumbing system's fittings used to connect any section of tubes or straight pipes. Elbow, tee, socket, reducer, etc. are a few examples.
Fixture unit	A measurement that expresses the load-producing impacts on the plumbing system caused by various types of plumbing fittings on a randomly selected scale.
Flange	it is a plate or ring that forms a rim at the end of the pipe when attached to a pipe. A flange junction is a pipe connection where the connecting sections are fastened together using flanges.
Fracture	Plumbing pipes, fixtures, or fittings may have portions that are fractured or cracked as a result of high pressure or clogging, which leads to leakage.
Gasket	Mechanical seals, generally ring-shaped and fitted for sealing flange joints
Horizontal pipe	Any pipe or fitting which makes an angle of more than 45° with the vertical
Induced siphonage	The extraction of water from a trap by a siphonage set up by the reduction of pressure at the outlet of the trap
Main soil pipe (MSP)	A pipe connecting one or more branch waste pipes to the drain
Main soil waste pipe (MSWP)	A pipe connecting one more branch soil waste pipe to the drain
Main ventilating pipe (MVP)	A pipe that receives a number of branch ventilating pipes
Main waste pipe (MWP)	A pipe connecting one or more branch waste pipes to the drain
Nipple	It is a length of pipe with thread on both sides that can be used to extend plumbing lines quickly
O-ring	An O-shaped ring that is attached to the faucet to prevent water from oozing out of the spout
Pipe ears	Two wings cast integrally with the pipe socket provided with holes to take fixing nails or screws

Plumbing Terminology	Description
Plunger	It is a tool used for cleaning normal blockage in drains and pipes, washbasin, etc.
Potable water	Water that satisfies the specifications of the Bureau of Indian Standards and is suitable for drinking, cooking, and domestic uses (BIS)
Sealing ring	It is a type of gasket used in connecting any fixture or joints to create leak-proof conditions.
Service pipe	The pipe that connects a multi-story building's distribution main on the street to its riser, or a single home's water supply, is subjected to water pressure from that main.
Soil pipe (SP)	The pipe that carries waste water and toilet waste
Supply pipe	The pipes which lead from the distribution main of water supply to the plumbing system of the house
Trap	It prevents sewer gases from entering the buildings
Vertical pipe	Any pipe which is installed in a vertical position or which makes an angle of not more than 45° with the vertical
Warning pipe	An overflow pipe so fixed that its outlet, whether inside or outside a building, is in a visible position where the discharge of any water from it can be readily seen
Washout valve	A device at the bottom of the tank used to empty the tank so it may be cleaned, maintained, etc.
Water line	A line drawn inside a cistern to designate the level at which the supply valve should be adjusted to cut off the water supply.
Water main	It is a pipe installed by the water undertakers with the intention of providing a broad water supply as opposed to delivery to specific clients. It also includes any equipment connected to such a pipe.
Water seal	Water in a trap that serves as a barrier to airflow through the trap
Water supply system	It is made up of the water supply pipe, the water distribution pipe, and all fittings, control valves, and connecting pipes that are inside or close to the building or premises

Table 2.1 Plumbing Terminologies

2.1.4 Plumbing Standards

Piping is governed by International Codes and Standards. The codes and standards which are to be referred for a given project depend on the client preferences and local regulations. Some of the international codes and standards that are followed widely the world over are described below:

1. **IPA and IAPMO-1**

   Indian Plumbing Association (IPA) jointly with International Association of Plumbing and Mechanical Officials, India (IAPMO-1) has published several codes relating to Plumbing.

   - 2017 Uniform Illustrated Plumbing Code-India (UIPC-I)
   - 2017 Water Efficient Products-India (WEP-I)
   - 2018 Water Efficiency and Sanitation Standard -India (2018We Stand -I)
   - 2020 Uniform Solar, Hydronics and Geo Thermal Code-India (USEC
   - 2019 Uniform Swimming

2. **Code of Basic Requirements for Water Supply, Drainage, and Sanitation (IS:1172-2007)**
   - Requirements of water supply for residences has been listed based on population of the community.
   - For Lower Income Group (LIG) and Economical Weaker Section of Society (EWS), the value of minimum requirement of water supply has been retained as 135 liters per head per day.
   - Fire demand in buildings has been catered to, by giving reference to a suitable standard.

3. **National Building Code 2016 PART 9 PLUMBING SERVICES Part 9 Section 1 covers water supply in buildings (SP7:2016)**
   - Encompasses public water supply, design of water supply systems, principles of conveyance and distribution of water within the premises, hot water supply system, inspection and maintenance of water supply.
   - Additional definitions universal pipe friction diagram
   - Added separate storage for flushing and domestic water.
   - Added domestic hot water supply installations.
   - Excludes water supply for firefighting and street cleaning.

4. **Part 9 Section 2 deals with Drainage and Sanitation**
   - Includes drain inside buildings and from the buildings up to the connection to public sewer, private sewage disposal system, or treatment work.
   - Covers design, construction, and maintenance of drains for surface water, subsoil water and sewage.
   - Also covers new technologies like ceiling-hung piping, single stack piping, the effect of sound in drainage, and newer materials like the HDPE or PP drainage piping materials.

5. **Code of practice for plumbing in multistoried buildings, Part 1: Water supply (IS:12183 – 2009)**
   - This code covers general requirements and regulations, design considerations, plumbing systems, distribution systems, storage of water an and inspection for water supply in multi-storied buildings.

6. **Code of practice for sanitary pipe work above ground for building (IS:5329 – 2007)**
   - The requirements for soil pipe, waste pipe, and ventilating pipe have also been included.
   - Traditional two-pipe systems as well as one-pipe and single stack systems.
   - Safeguards for single-stack systems have been covered in detail.

2.1.5 International System (SI) of Measurement

A plumber needs to be proficient at measuring plumbing supplies with the aid of measuring instruments and have no trouble handling unit conversions. A plumber should also be able to read and comprehend the various symbols used in plumbing designs. According to the plumbing work's requirements and strategy, plumbing supplies are required. Plumbing accessories and fixtures come in a variety of sizes and styles on the market. The plumbing fixtures can range in size from an inch to a foot and a meter in height. Plumbing supplies including water tanks, storage containers, and flush tanks are also available based on volumetric capacity.

Measurement of Length

A plumber uses metallic tapes, cloth tapes, a scale, and foot rule for measuring. Metallic tape should be used for accuracy in the measurement. Meter and its divisions are printed on measuring tapes.

The symbol of feet is (') and the symbol of inch is (“).

- For example, the meaning of 4'-9” is 4 feet 9 inches.
- Both the systems i.e., metric system and F.P.S. are used in plumbing.

The conversion table for length is depicted below:

Metric System	
1 metre	= 10 decimeter (dm)
1 metre	= 100 centimetre (cm)
1 metre	= 1000 millimetre (mm)
10 millimetre	= 1 centimetre (cm)
10 centimetre	= 1 decimeter (dm)
10 decimetre	= 1 meter (m)
FPS System	
1 feet	= 12 inches
3 feet	= 1 yard
Inter-relation of Metric and FPS system	
Both type of systems can be interrelated, for taking length, in the following manner:	
1 inch = 25.4 mm = 2.54 cm	
1 metre = 39.37 inches = 1.09 yard	

Table 2.2 Length Conversion Table

Measurement of Weight

Weight measurement, using both the systems, is done in the following:

1 kilogram	= 10 hectograms
1 kilogram	= 100 decagram
1 kilogram	= 1000 gram
100 kilogram	= 1 Quintal
1000 kilogram	= 1 metric ton
1 kilogram	= 2.2046 pounds

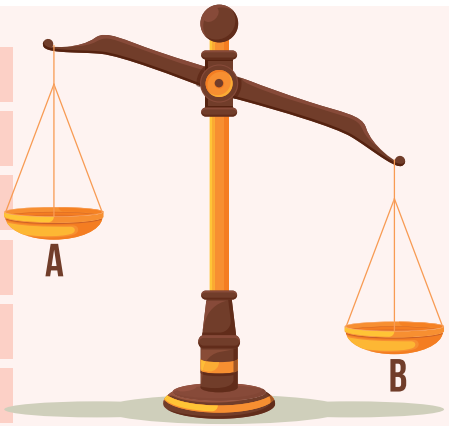


Table 2.3 Weight Conversion Table

Measurement of Volume

Capacity conversion is depicted in the following table:

1 liter (l)	= 1 cubic decimeter	= 61.0270515 cu.in. or 0.03531 cu. ft. or 1.0567
1 liter (l)	= 1 cubic decimeter	= 61.0270515 cu.in. or 0.03531 cu. ft. or 1.0567
10 liters	= 1 deciliter (Dl.)	= 2.6417 gal., or 1.135 pk.
10 deciliters	= 1 hectoliter (Hl.)	= 2.8375 bu.
10 hectoliters	= 1 kiloliter (Kl.)	= 61027.0515 cu.in. or 28.375 bu.
1 cubic foot	= 28.317	
1 gallon, Amer	= 3.785 l.	
1 gallon, Brit	= 4.543 l.	
1 gallon	= 4.546 liter	

Table 2.4 Volume Conversion Table

Measurement of Density

Density conversion is depicted in the following table:

1 lb./ft3	= 16.018 kg/m3
1 kg./m3	= 0.0624 lb./ft3
1 lb./cu.inch	= 27.68 gms/cu.cm.

Table 2.5 Density Conversion Table

Measurement of Pressure

Pressure conversion is depicted in the following table:

1 lb. /ft^2	= 4.8824 kg/m^3	= 1 lb/meter^2 = 6.895 Kg. Newton/M^2
1 lb./inch^2	= 0.0703 kg/cm^3	

Table 2.6 Pressure Conversion Table

Comprehensive Conversion Table

Millimeters	= 25.400	x inches
Meters	x 3.2809	= feet
Meters	= 0.3048	x feet
Kilometers	x 0.621377	= miles
Kilometers	= 1.6093	x miles
Square centimeters	x 0.15500	= square inches
Square centimeters	= 6.4515	x square inches
Square meters	x 10.76410	= square feet
Square meters	= 0.09290	x square feet
Square kilometers	x 247.1098	= acres
Square kilometers	= 0.00405	x acres
Hectares	x 2.471	= acres
Hectares	0.4047	x acres
Cubic centimeters	x 0.061025	= cubic inches
Cubic centimeters	= 16.3266	x cubic inches
Cubic meters	x 35.3156	= cubic feet
Cubic meters	= 0.02832	x cubic feet
Cubic meters	x 1.308	= cubic yard

Continued...

Cubic meters	= 0.765	x cubic yard
Liters	x 61.023	= cubic inches
Liters	= 0.01639	x cubic inches
Liters	x 0.26418	= U.S.gallons
Liters	= 3.7854	x U.S.gallons
Grams	x 15.4324	= grains
Grams	= 0.0648	x grains
Grams	x 0.03527	ounces, avoirdupois
Grams	= 28.3495	x ounces, avoirdupois
Kilograms	x 2.2046	= pounds
Kilograms	= 0.4536	x pounds
Kilograms per sq.cm.	x 14.2231	= lb. Per. sq.in.
Kilograms per sq.cm.	= 0.0703	x lb.per.sq.in
Kilogram per cubic meter	x 0.06243	= lb.per.cu.ft.
Kilogram per cubic meter	= 16.01890	xlb.per.cu.ft.
Metric tons (1000 kilograms)	x 1.1023	x tons(2000 lb.)
Metric tons (1000 kilograms)	= 0.9072	x tons (2000 lb.)
Kilowatts	x 1.3405	= horsepower
Kilowatts	= 0.746	x horsepower
Calories	x 3.9683	= B.t.u.
Calories	= 0.2520	x B.t.u.
Francs	x 0.193	= dollars
Francs	= 5.18	x dollars

Table 2.7 Comprehensive Conversion Table

Measurement Tips

- To find the circumference of a circle, multiply the diameter by 3.1416.
- To find the diameter of a circle, multiply the circumference by .31831.
- To find the area of a circle, multiply the square of the diameter by .7854.
- The radius of a circle x6.283185 = the circumference.
- The square of the circumference of a circle x .07958 = the area.
- Half the circumference of a circle x half its diameter = the area.
- The circumference of a circle x .159155 = the radius.
- The square root of the area of a circle x .56419 = the radius.
- The square root of the area of a circle x 1.12838 = the diameter.
- To find the diameter of a circle equal in area to a given square, multiply a side of the square by 12838.
- To find the side of a square equal in area to a given circle, multiply the diameter by .8862.
- To find the side of a square inscribed in a circle, multiply the diameter by .7071.
- To find the side of a hexagon inscribed in a circle, multiply the diameter of a circle by .500.
- To find the diameter of a circle inscribed in a hexagon, multiply a side of the hexagon by 1.7321.
- To find the side of an equilateral triangle inscribed in a circle, multiply the diameter of a circle by .866
- To find the diameter of a circle inscribed in an equilateral triangle, multiply a side of the triangle by .57735.
- To find the area of the surface of a ball (sphere), multiply the square of the diameter by 3.1416.
- To find the volume of a ball (sphere), multiply the cube of the diameter by .5236.
- Doubling the diameter of a pipe increases its capacity four times.
- To find the pressure in pounds per square inch at the base of a column of water, multiply the height of the column in feet by .433.
- A gallon of water (U.S. standard) weighs 8.336 pounds and contains 231 cube inches. A cubic foot of water contains 7½ gallons, 1728

Notes

Unit 2.2 - Plumbing Materials

Unit Objectives

At the end of this Unit the trainee will be able to:

1. State the names, characteristics and applications of different pipes, pipe fittings, fixtures supports and materials used in plumbing
2. Discuss the uses and limitations of various types of fixtures
3. List the types and grades of pipes, fittings, fastening hardware (such as anchors, studs, bolts, clamps and nuts), supports, restraints, blocking and wall hangers and their properties
4. Describe the installation process of pipes and fittings for various plumbing applications

2.2.1 Pipe Materials

The plumbing system in a building distributes water for drinking, heating, and washing, as well as for the removal of waterborne wastes. It consists of pipes, drain fittings, valves, valve assemblies, and devices.

Pipe Materials

There are various types of materials that are used for manufacturing pipes include:

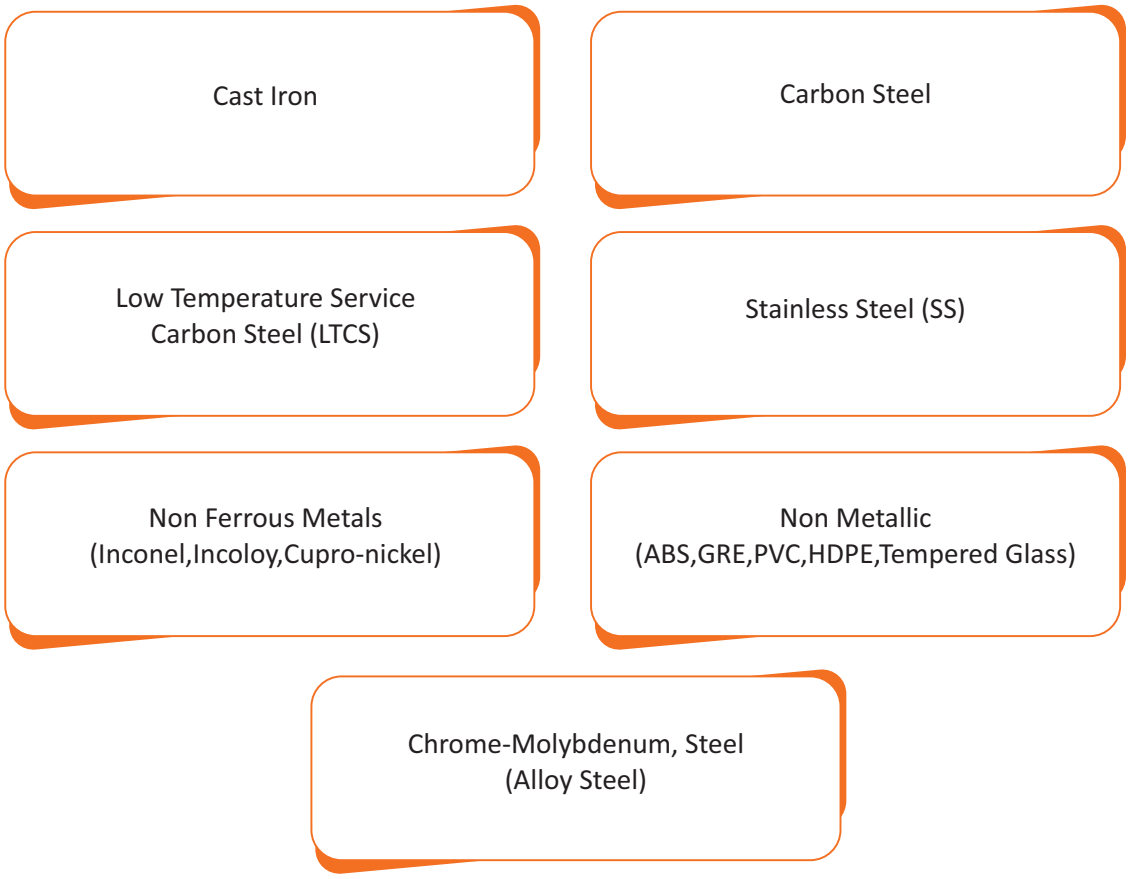


Fig 2.4 Pipe Materials

2.2.2 Types of Pipes

I. Cast Iron Pipe

- Cast Iron Pipe is used as a pressure pipe for transmission of water, gas, and sewage, and as a water drainage pipe.
- These are available with flanged ends or one end with socket & other with a spigot.

II. Ductile Iron Pipe

- Ductile Iron Pipes are improved versions of Cast Iron pipes.
- It is commonly used for potable water transmission and distribution.

III. Galvanized Pipe

- Galvanized Iron Pipe is mainly used in water supply distribution.
- These pipes are made of different grades i.e. Light, Medium, and Heavy depending upon the thickness of the pipe used. These are color-coded for identification - light – yellow band, medium – blue band, and heavy – red band
- Pipes with diameters in size from 15 mm to 150 mm are used in distribution.

IV. CPVC Pipes

- Chlorinated Polyvinyl Chloride (CPVC) Pipe is primarily used for supplying hot and cold potable water.
- It is also used in industrial liquid applications.
- Chlorinated polyvinyl chloride is a thermoplastic pipe material.

Fig 2.5 Cast Iron Pipe

Source : https://www.indiamart.com/proddetail/cast-iron-pipes-1380828930.html

Fig 2.6 Ductile Iron Pipe

Source : https://www.indiamart.com/proddetail/ductile-iron-double-flanged-pipe-16004615973.html

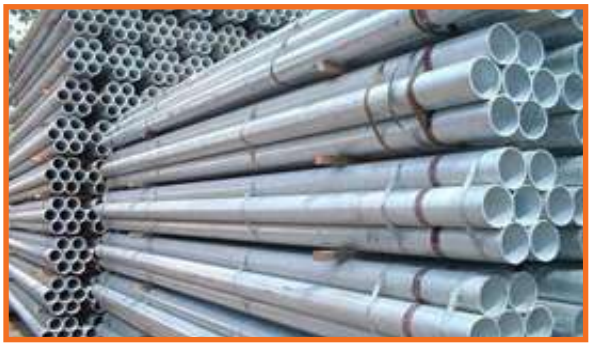


Fig 2.7 Galvanized Pipe

Source : https://www.indiamart.com/proddetail/galvanized-iron-pipe-18923021033.html

Fig 2.8 CPVC Pipe

Source : https://www.indiamart.com/proddetail/cpvc-pipe-4355787688.html

V. PEX or XLPE Pipes

- PEX or XLPE is a form of polyethylene with cross-links, formed into tubing.
- PEX Pipe is primarily used in - building services, pipe work systems, domestic water piping, natural gas and offshore oil applications, chemical transportation and transportation of sewage and slurries.

VI. Polypropylene Pipes

- These are made of polypropylene "random copolymer".
- Polypropylene Pipe is primarily used for - inner hot water and cold-water supply conduits, industrial pipelines.

VII. Stoneware Pipes

- Stoneware pipes are made of clay.
- They are s primarily used in - sewerage systems for underground drainage, industrial drainage, irrigation, chemical industry for transporting the highly corrosive chemical etc.

VIII. Un-Plasticized Pipes

- Un-plasticized Polyvinyl (UPVC) Pipe is primarily used in - ventilation pipe work, rainwater applications, soil and wastewater discharge system.

Fig 2.9 PEX Pipe
Source : https://dir.indiamart.com/impcat/pex-pipe.html

Fig 2.10 Polypropylene Pipe
Source : https://www.pvcpipelocators.com/pvc-vs-pp-pipe/

Fig 2.11 Stoneware Pipes
Source : https://www.indiamart.com/proddetail/stoneware-pipe-22698988248.html

Fig 2.12 Un-Plasticized Pipes
Source : https://www.indiamart.com/proddetail/unplasticized-polyvinyl-chloride-pipes-6394822973.html

IX. Copper Pipes

- Copper Pipe as the name suggests are made up of copper. It is most often used in - supply of hot and cold tap water, as refrigerant line in HVAC systems.
- Copper offers a high level of resistance to corrosion however; it is becoming very costly.

X. Stainless Steel Pipes

- Stainless Steel Pipe is used in marine environments where salt water would erode another metal pipe.
- These pipes are strong and highly resistant to corrosion.
- However, even more, expensive than copper pipes.

Fig 2.13 Copper Pipe
Source : https://www.indiamart.com/proddetail/copper-pipes-17500110133.html

Fig 2.14 Stainless Steel Pipe
Source : https://www.indiamart.com/proddetail/stainless-steel-pipe-20989662455.html

2.2.3 Pipe Fittings

In pipe plumbing systems, fittings are used to join straight pipe or tubing pieces, to adapt to various sizes or forms, as well as for additional uses like regulating or metering fluid flow. Fittings are a small part of the plumbing system. In a pipe plumbing system, fittings are used to join sections of straight pipe or tubing, to adapt to various sizes or forms, and for additional uses, such as regulating or metering fluid flow. We can state that water supply fittings, such as elbows, tees, sockets, reducers, etc., are used to distribute water from the main pipe to other pipes of equal or smaller size, change the direction of flow, etc. Different types of fittings are listed below:

Fig 2.15 Different types of fittings

I. Collar

- A pipe fitting in the form of a sleeve for jointing the spigot ends of two pipes in the same alignment is known as a collar.

Fig 2.16 Collar
Source: Indiamart

II. Elbow

- An elbow is a pipe fitting used to provide a change in direction, often a 90° or 45° angle, between two lengths of pipe or tubing. The ends could be socketed, threaded (often female), butt-welded, etc. The fitting is referred to as a reducing elbow or reducer elbow when the two ends are of different sizes. Elbows are categorized based as below:
  - **Long Radius (LR) Elbows**–radius is 1.5 times the pipe diameter
  - **Short Radius (LR) Elbows**–radius is 1.0 times the pipe diameter.
  - **90° Elbow**–where change in direction required is 90°
  - **45° Elbow**–where change in direction required is 45°

Bend 45°

Bend 90°

YT Joint

Double YT Joint

T Trap

Table 2.8 Joints
Source: Indiamart

III. Gasket

Gaskets or Mechanical seals are used to seal flange joints. It comes in a variety of designs, compositions, and features. These are non-metallic, spiral-wound, and ring-jointed and are frequently employed.

IV. Coupling

Couplings are used to connect two pipes to each other. If the pipe sizes are different, the fitting may be referred to as an adapter, a reducing coupling, or both. A piece of pipe with internal threads for joining two pipes with screwed ends.

V. Union

A pipe fitting is used to connect two ends of pipes that cannot be turned independently of one another. A nut, a female end, and a male end make up the three components of a typical union pipe. The nuts then apply the necessary pressure to seal the connection after the female and male ends have been linked. Since the union's mating ends may be switched out, changing a valve or other device can be done with the least amount of downtime.

VI. Reducer

A red**Source:** ucer is used for a change in pipe size to meet hydraulic flow requirements of the system.

VII. Tee

A tee is used to combine (or split) fluid flow. It is offered with a female-threaded side outlet, opposing solvent-weld sockets, or female thread sockets. Tees can be used to shift a pipe run's direction or connect pipes of various diameters. They are used to move two-fluid combinations and come in a range of materials, sizes, and finishes. Tees can vary in size from equal to unequal, with equal tees being the most popular.

Fig 2.17 Gasket
Source: Indiamart

Fig 2.18 Coupling
Source: Indiamart

Fig 2.19 Union
Source: Indiamart

Fig 2.20 Reducer
Source: https://www.enggcyclopedia.com/2019/04/piping-reducer/

Fig 2.21 Tee
Source: Indiamart

VIII. Nipple

A nipple is a small section of pipe that joins two other fittings. It is often made of male-threaded steel, brass, chlorinated polyvinyl chloride (CPVC), or copper (sometimes bare copper). A "close nipple" is a nipple with uninterrupted threading. Plumbing and hoses frequently employ nibbles. a tubular pipe for connecting the pipes that is smaller than 300 mm in length and has both ends threaded.

Fig 2.22 Nipple
Source: Indiamart

IX. Trap

A trap in plumbing is a P, U, S, or J-shaped pipe that is positioned beneath or inside a plumbing device. To stop sewer gases from entering the building, the bend is used. In addition to smelling bad, the gases might make you sick and possibly explode if they were allowed back inside the house.

X Cross

Four-way fittings, commonly referred to as cross branch lines, are a type of pipe fitting that joins four pipes. A cross often has solvent-welded socket or female-threaded ends and has one inlet and three outlets (or vice versa). Cross fittings, which are in the middle of four connection sites, may cause pipes to become stressed as temperatures fluctuate.

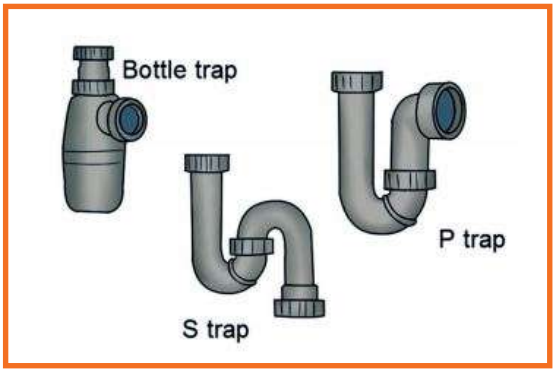


Fig 2.23 Trap
Source: https://www.mepskills.com/2020/07/what-is-pipe-fitting-what-are-types-of.html

Fig 2.24 Cross
Source: Indiamart

XI. Offset

A combination of elbows, which bring the pipe out of line but parallel with it.

Fig 2.25 Offset
Source: Indiamart

2.2.4 Pipe Joints

Joints are used to attach pipes together. The assembling of pipes uses a variety of joints. Fitting refers to the process of joining two or more pipes together. Depending on the demand, several pipe joints are utilized for various pipes. Major plumbing system components that connect many pipes together are called pipe joints. The specified pipe junction must bear the pressure of each pipe. Different types of pipe joints used in plumbing are listed below:

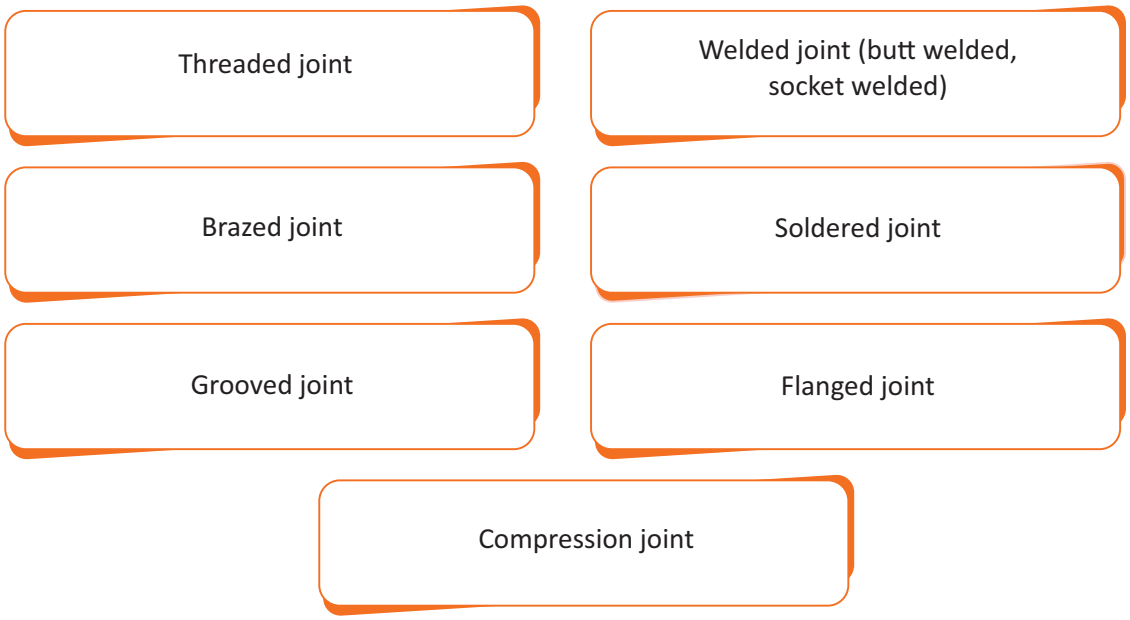


Fig 2.26 Types of Joints

I. Threaded Joint

A threaded joint is one in which the pipes are screwed together using threads that are built into each pipe. One pipe has threads on the inside, while the other has threads on the outside. There are threaded cast iron, copper, PVC, and G.I. pipes available. There are threaded joints for pipes with a diameter of 6 mm to 300 mm. For low-temperature and low-pressure flows, they are preferred. The joints may expand and leak in hot places as a result of thermal expansion. Threaded joints are simple to install, but they need to be well-maintained.

II. Welded Joints (Butt-welded joints)

Butt-welding is the most common method of joining piping used in large commercial, institutional, and industrial piping systems. Material costs are low, but labour costs are moderate to high due to the need for specialized welders and fitters. The interior surface of a butt-welded piping system is smooth and continuous which results in low pressure drop.

Fig 2.27 Threaded Joint
Source : https://www.amazon.com/Stainless-Female-Degree-Threaded-Fitting/dp/B01MR0N5IF

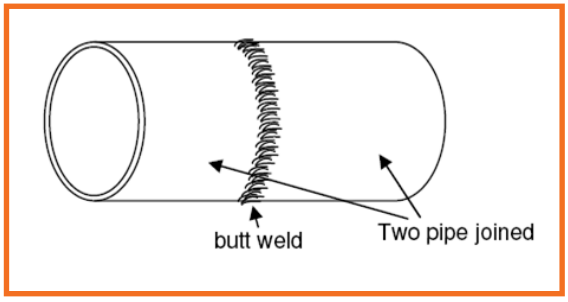


Fig 2.28 Butt-welded joint
Source : https://www.enggcyclopedia.com/2011/08/butt-weld/

III. Socket-Welded Joints

In situations when there is a substantial probability of joint leakage, socket welded joints are used. As demonstrated above, pipes are joined by inserting one into another and welding around the connection. Pipes with various diameters work well in this kind of junction. Compared to other mechanical joints, socket welded joints produce good results.

IV. Brazed Joints

Brazing is the process of joining pipes using molten filler material at temperatures above 840°C. Copper or copper alloy pipes are brazed together to form connections. It is crucial to remember that the pipe material's melting point should be higher than the filler materials. When temperatures are moderate, brazed joints are recommended since they have less mechanical strength.

V. Soldered Joints

Brazing and soldering are similar processes. The filler material melts when soldering below 840oC. Copper and copper alloy pipes are connected by soldering. Flux or another metal-joining agent is used during soldering to stop metal from oxidizing owing to the flame. Soldered joints have low mechanical strength and are ideal for low-temperature environments.

VI. Grooved Joints

Grooved joints are those where two pipes are connected by creating narrow incisions or depressions at the ends of the pipes with the use of sockets or couplings. The labor cost is lower since the grooved joints are simpler to assemble. For routine maintenance, it is simple to remove and reinstall the piping system. Their primary purpose of them is fire protection.

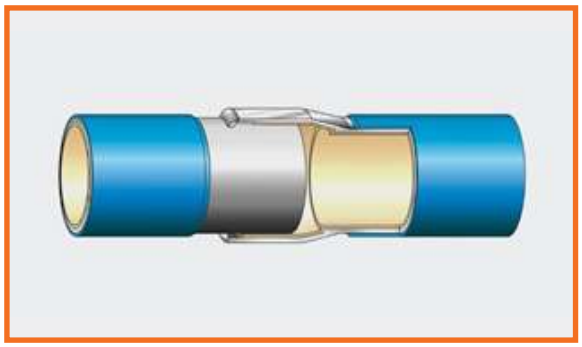


Fig 2.29 Socket-welded joints
Source : https://ftpipelinesystems.co.uk/pipe-joints/socket-weld-joint/

Fig 2.30 Brazed joint
Source : https://theconstructor.org/building/types-of-pipe-joints-in-plumbing/12559/

Fig 2.31 Solder joint
Source : https://www.familyhandyman.com/project/how-to-solder-copper-pipe-joints/

Fig 2.32 Grooved joint
Source : https://www.victaulic.com/grooved-technology/

VII. Flanged Joints

Pipes in pumping stations, filter plants, hydraulic labs, boiler buildings, etc. are frequently joined using this junction. Although these connections are expensive, they are preferred because of how simple it is to assemble and disassemble them. When necessary, these joints can be taken apart and put back together. Flanged ends are present at both ends of a pipe. Pipes are linked at the proper level and close to one another on both ends. Between the flanges is a strong rubber washer that is fastened. In most cases, welding or threading is used to attach flanges to the pipe. A flange-type joint may also be referred to as a lap joint in some circumstances. It can also be produced using a forging technique and pipe end machining.

VIII. Compression Joints

These are used to connect the pipe without any prior preparation. These joints can be installed at a very low price. Compression joints are used to link pipes with plain ends by mounting fittings at the ends of the pipes. Threaded couplings or fittings are used to attach the ends of the pipes. Joints are positioned correctly to monitor the flow pressure because leakage could otherwise happen. Different types of materials are used to make these fittings. The fittings are chosen based on the needs.

Fig 2.33 Flanged Joint

Source : https://ftpipelinesystems.co.uk/pipe-joints/socket-weld-joint/

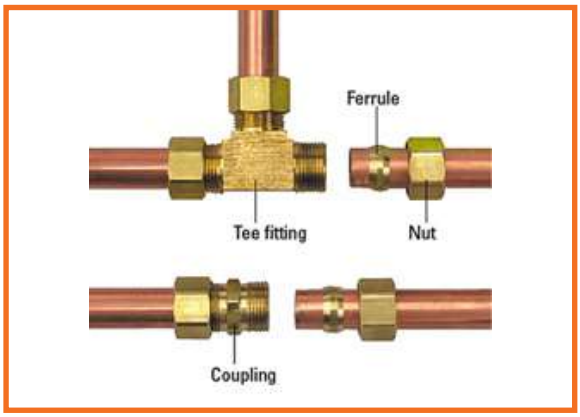


Fig 2.34 Compression Joint

Source : https://piping-info.blogspot.com/2009/08/types-of-piping-joints.html

Notes

2.2.5 Valves

The water supply mains use brass or iron valves to ensure good pipeline operation. The flow of fluids such as liquid, gas, condensate, etc. is stopped or controlled by valves. These are divided into categories based on how they are used, such as isolation, throttling, and non-return corrector. According to their intended application and style of construction, many types of valves are produced. Various type of valves are available depending upon the type of construction as follows:

I. Sluice Valve

It is positioned at a crucial location, such as any pipe entry. It could be the beginning of a brand-new pipe coming from a tank, one of the tank's many branches, or the main header. When necessary, this valve isolates the water supply. The nominal bore of the waterway serves as a specification for the sluice valve. 50 mm, 65 mm, 80 mm, 100 mm, 150 mm, 200 mm, 250 mm, and 300 mm are the standard sizes. Class 1 and Class 2 sluice valves are available.

Fig 2.35 Sluice Valve
Source: Indiamart

Class	Test Pressure kg/cm^2		Max. working Pressure kg/cm^2
	Body	Seat	
Class 1	20	10	10
Class 2	30	15	15

Table 2.9 Test pressure in sluice valve

II. Air Valve

When the pipe is filled with water, it is configured to automatically release the air. Additionally, when the pipe is drained, this valve allows air to enter. This valve, which is permanently attached to the end of a communication line, regulates or interrupts the flow of water. The standard bore (diameter) of the socket or pipe outlet to which it is affixed serves as the specification for this valve. 8 mm, 10 mm, 15 mm, 20 mm, 25 mm, 32 mm, 40 mm, and 50 mm are the standard sizes. Leaded tin bronze or cast brass are used to make the washer plate and body components. The washers are constructed of nylon, rubber, leather, or fibre. Both an internally threaded and an externally threaded version of this valve are available.

Fig 2.36 Air Valve
Source: Indiamart

III. Scour Valve

This valve is installed at a pipeline's lower level so that such sections can be fed with fluid and emptied for maintenance. Natural drains receive the water and disperse it there. It functions essentially like a sluice valve, but the nomenclature is different because of how it is used.

IV. Gate Valve

It is used to start or stop the water flow. It can also be used to achieve minimum flow restriction for fluid flowing in a straight line. These valves are typically either fully open or fully closed when in use. These valves have a variety of liquid applications and create a secure seal when closed.

V. Parallel Side Gate Valve

It has two discs that glide between the two parallel body seats without using a spreading mechanism. The internal and external screws on the spindle, which might be of the rising or non-rising kind, activate the valve discs.

VI. Globe Valve

It is a kind of valve used to manage pipeline flow. A moving disc element and a stationary ring seat placed in a usually spherical body make up a valve component. The globe valve is utilized to regulate flow.

Fig 2.37 Scour Valve
Source: Indiamart

Fig 2.38 Gate Valve
Source: Indiamart

Fig 2.39 Parallel Side Valve
Source: Indiamart

Fig 2.40 Globe Valve
Source: Indiamart

VII. Angle Valve

It is used to control the passage of a fluid like liquids, gases, fluidized solids, or slurries by opening, closing, or partially obstructing multiple channels. This kind of valve typically has a spherical body with body ends that are fitted at an angle to one another and a disc that rotates up and down. The internal or exterior screw on the spindle turns the valve into action. The spindle could be of the rising or non-rising type.

VIII. Check valve or non-return valve

It is a valve that allows (fluid) water to flow in one direction while stopping all backflow. It is controlled by the pressure from above and lacks any external controls.

IX. Ferrule

It is used for connecting a service pipe to the water main. It is usually made of non-ferrous metal and screwed to the main pipe.

X. Foot Valve

It is a valve that the pump uses. Since it ensures that the pump is prepared for operation, it is also known as a check valve. The foot valve ensures that there is enough fluid in the pump even when it is turned off so that it may restart. The foot valve in a well will be situated between the pump and the water's surface. The foot valve for a water intake system is located at the end of the water intake pipe. A strainer on the outside of the foot valve prevents blockages as well.

XI. Float Valve

When the water tank or flush toilet is filled, it is used to stop the flow of water to prevent overflow. The float rises along with the rising water level, and when it reaches a preset level, the lever is forced to close the valve, stopping the flow of water. A fitting called a float valve is used to fill water tanks and flush toilets.

Fig 2.41 Angle Valve
Source: Indiamart

Fig 2.42 Non-Return Valve
Source: Indiamart

Fig 2.43 Ferrule Valve
Source: Indiamart

Fig 2.44 Foot Valve
Source: Indiamart

Fig 2.45 Float Valve
Source: Indiamart

2.2.6 Fixtures

A plumbing fixture is a component that connects to the building's plumbing system and transports water. Showers, tubs, sinks, faucets, and bathtubs are the most popular plumbing fixtures. A fitting is something that can be hung by a hook, screw, or nail as opposed to a fixture, which can be installed into walls or the floor. Commonly used sanitary fittings and fixtures are explained below:

I. Bathtub

It is installed in a bathroom and is made of marble, plastic, enameled iron, vitreous material, etc. Its dimensions range from 1.7 to 1.85 meters in length, 70 to 75 centimeters in width, and 43 to 45 centimeters in depth to the outlet end. The tank may be filled with cold and hot water using the provided faucets, and any extra water can be drained using the overflow line. Similar to the sink, the drain has a rubber plug and a waste coupling with a waste seal trap.

II. Washbasin

It is used for cleaning hands, faces, etc. These are typically made of Vitreous China, glass, marble, burned fireclay, ceramic, enamel over steel, etc. Washbasins come in a variety of colors, styles, and shapes.

III. Water Closet

It is designed to take human waste. It is connected to the soil pipe, then to a municipal sewer or septic tank, through a suitable trap. Water from the cistern tank is used to flush the excreta. There are two types of water closets:

1. Indian type
2. European type

IV. Faucet

Faucet is used to control the liquid flow, especially water, from a pipe. It is also known as water tap. It is available in a bathroom, kitchen or sink, as per use.

Fig 2.46 Bathtub
Source: Indiamart

Fig 2.47 Washbasin
Source: Indiamart

Fig 2.48Indian type
Source: Indiamart

Fig 2.49 European type
Source: Indiamart

Fig 2.50 Faucet
Source: https://www.ubuy.co.in/product/4W3A7JS-amazing-force-brushed-nickel-kitchen-faucet-with-pull-down-sprayer-kitchen-sink-faucet-single-handle

V. Sink

It is a rectangular, shallow, watertight tank constructed out of stainless steel, vitreous china, fireclay, or concrete. It is used to clean utensils, clothes, and other items. There is a hole in the flow of a sink where a waste coupler and waste pipe can be fixed.

VI. Flushing cistern

It is a small tank that stores water for flushing toilets and urinals. Cast iron, glazed earthenware, glazed vitreous, or any other material can be used to make it. A cistern's water storage capacity ranges from 5 to 10 to 15 litres, depending on its size. The most typical cistern size is 10 litres.

VII. Geyser

It is used to heat water. It is available in various capacities as per the requirement.

Fig 2.51 Sink
Source: Indiamart

Fig 2.52 Flushing cistern
Source: Indiamart

Fig 2.53 Geyser
Source: Indiamart

2.2.7 Fastener

A fastener is any one of a large variety of mechanical tools or components that are used to rigidly attach two or more items to one another. Fasteners make it possible to separate or disassemble the parts without causing damage. They can also be utilized as long-term joints, though. Different types of fasteners include screws, nuts, bolts, nails, washers, and more. Different types of fasteners used in industrial applications are listed below:

I. Nuts and Bolts **II. Washers**

III. Screws **IV. Nails**

V. Anchors **VI. Rivets**

VII. Pins **VIII. Retaining Rings**

IX. Inserts

I. Nuts and Bolts

One of the most popular types of industrial fasteners is the nut and bolt. They work together in tandem and hold two or more components together. The nut is tightened on one end of the bolt after it has been inserted through the bolt holes between the parts. There are various types of nuts and bolts as mentioned below:

a) Hex nuts b) Coupling nuts c) Lock nuts

d) Square nuts e) Flange nuts f) Wing nuts

g) Slotted nuts
h) U-nuts
i) Speed nuts
j) Push nuts
k) Jam nuts
l) Axle nuts
m) Castle nuts
n) Rivet Nuts
o) Weld Nuts
p) Barrel Nuts
q) Shear Nuts
r) Tri-Groove Nuts
s) Keps-K Lock Nuts
t) Knurled Thumb Nuts
u) Wheel Nuts

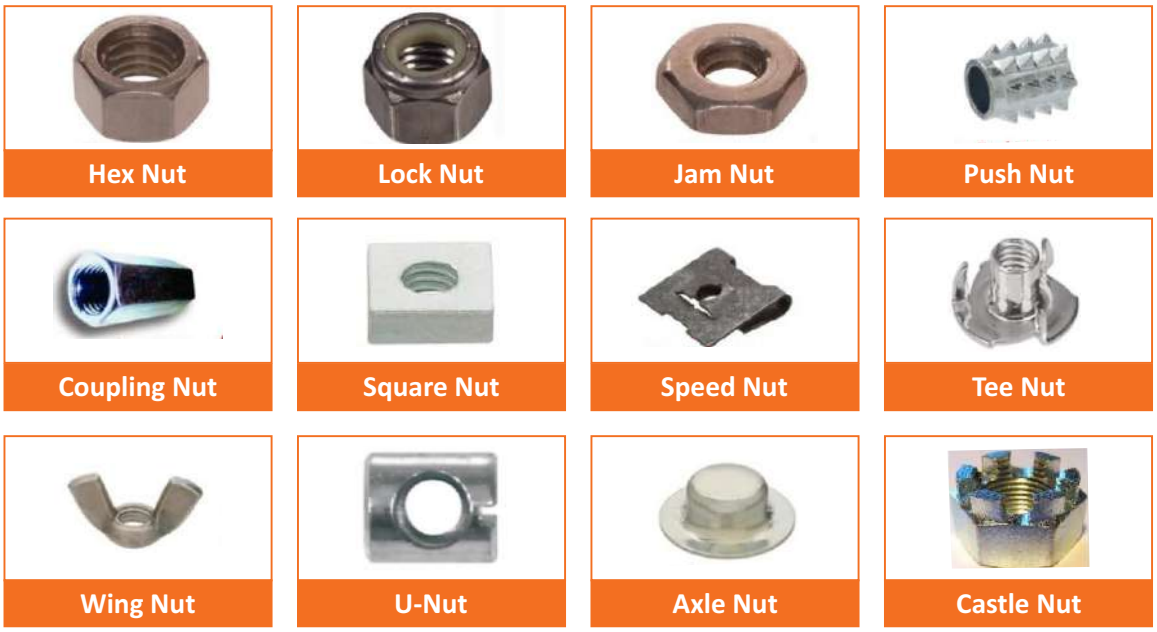


Fig 2.54 Different Types of Nuts
Source: https://whatispiping.com/types-of-fasteners/

Many different types of bolts are available in the market. The most common types of bolts that are used for industrial applications are:

a) Carriage bolts
b) Hex bolts
c) U-bolts
d) Eye bolts
e) Leg bolts
f) Flange bolts
g) Allen bolts
h) Plow bolts
i) Square head bolts
j) Shoulder bolts or Stripper bolts

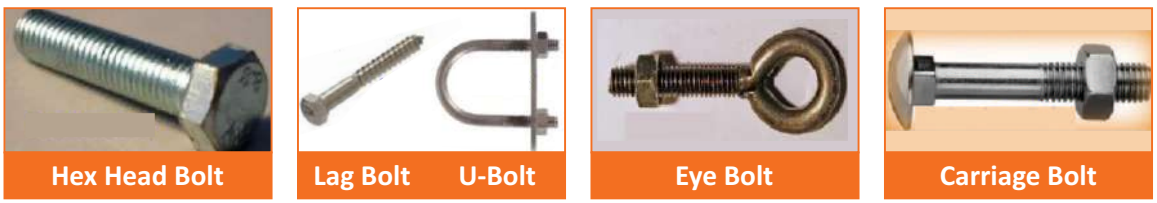


Fig 2.55 Different Types of Bolts
https://whatispiping.com/types-of-fasteners/

I. Washers

In order to distribute the load of the fastener uniformly throughout the surface of the material, washers are occasionally inserted in between nuts and bolts. A washer is a flat, elongated disc with a hole in the middle. Washers can be constructed from non-metals or from metals. Following are the purpose of washers:

- Isolation of Components
- Reduction of leakage
- Alleviation of friction, and
- Prevention of loosening during vibration

Some common types of washers are:

- **Plain Washers:** Plain washers are used for load distribution and isolation purposes. Plain washers can be of various types like:
- Round and thin Flat Washers for general use.
- Torque Washers for use in woodworking projects.
- Fender Washer used in car fenders.
- Finishing Washers used with countersank screws, and
- C-washers
- **Spring Washers:** These types of fasteners act like a spring as they develop axial flexibility to make the joint more elastic. This can avoid unintended loosening during vibration. The main types of Spring Washers are:
  - Belleville Washer
  - Crescent Washer
  - Dome Spring Washers, and
  - Wave Spring Washers
- **Lock Washers:** This type of washer uses various mechanisms to prevent nuts, screws, and bolts from loosening. Lock washers are much better than spring washers and can be of the following types:

Fig 2.56 Different Types of Washers
Source : https://whatispiping.com/types-of-fasteners/

- External tooth lock washer
- Internal tooth lock washer
- Split lock washer, and
- Tab washer

- **Beveled Washers:** These washers add stability when attaching unparallel surfaces.
- **Structural Washers:** Usually thicker, Structural washers are used in heavy-duty applications.

III. Screws

Screws are the most versatile types of fasteners It is quite easy to use. A pilot hole must first be drilled in a material before the screw can be simply fitted using a screwdriver. Typically, they have male threads that begin at the tip. Typically, self-threading screws produce the thread while being installed. Different types of screws are listed below:

a. Self-drilling screws
b. Machine screws
c. Sheet metal screws
d. Deck screws having a self-tapping design.
e. Wood screw having coarse thread and tapered head.
f. Grub Screws without a head used to prevent rotation or movement between two parts.
g. Masonry screws having a flat tip and hex-head designs.
h. Countersunk screw
i. Hex lag screw
j. MDF screws
k. Drywall screws

Fig 2.57 Different Types of Screws
Source : https://whatispiping.com/types-of-fasteners/

IV. Nails

The oldest types of fasteners still in use today are nails. It continues to be a standard home item. Since they lack threads, nails typically have less force than screws. The most widely used types of nails are:

a. Common nails have a thicker shank.

b. Box nails with a diamond point tip.

c. Roofing nails with a wide head.

d. Framing nails are specially designed for flush installation and easy concealment.

e. Brad nails for easily blending into wood trims.

f. Flooring nails for use with flooring materials.

g. Drywall nails for reduced slippage.

h. Finishing nails with small flatheads

V. Anchors

A specific kind of fastener called an anchor is used to secure objects to drywall or concrete. They ingrain themselves into the substance and secure the thing. Different types of anchors are employed for various functions. Some common types of anchors are:

a. Internally threaded anchors

b. Externally threaded anchors

c. Acoustical wedge anchors

d. Masonry screw and pin anchors

e. Bonded anchors

f. Screw anchors

g. Double expansion shield anchors

h. Hollow wall anchors

i. Drop-in anchors

j. Sleeve anchors

k. Plastic anchors

l. Drive anchors

VI. Rivets

Rivets are referred to as permanent fasteners because they establish a permanent junction between two items. Rivets, which are made comprised of a cylindrical shaft with a head and a tail at either end, provide excellent support against shearing forces. This kind of fastener is surprisingly strong while being lightweight. Installing rivets requires the use of a specialized tool known as a rivet gun. After removal, rivets cannot be used again. Some common types of rivets are:

a. Blind rivets

b. Pop rivets (Closed-end, Open end, Countersunk)

c. Semi-tubular rivets

d. Large flange rivet

e. Solid rivets

f. Tri-fold rivet

g) Split rivets
h) Drive rivets
I) Structural rivets
j) Colored rivets
k) Multi-grip rivet

VII. Pins

Pins are unthreaded mechanical fasteners usually inserted through preformed holes. The most common types of pins for industrial usage are:

a. Dowel pin
b. Slotted pin
c. Coiled pin
d. Roll pin
e. Grooved pin
f. Split pin
g. Wedge pin or tapered pin, known as cotter

VIII. Retaining Rings

Retaining rings are a sort of metallic fastener that is used to hold many elements together but is not permanent. Metal spirals and semi-circular sections are typically used. Many different types of machinery and housing parts need retaining rings. The various types of retaining rings are:

a. Constant section retaining ring
b. Snap retaining ring
c. Tapered section retaining ring
d. Axially assembled retaining rings
e. Spiral retaining ring
f. Radially assembled retaining ring
g. Circular push-on
h. Bowed-E retaining rings
i. External shaft retaining rings
j. Self-locking retaining rings

IX. Inserts

As mechanical fasteners, inserts handle a variety of duties. Typically, they are employed to secure anchor bolts to dangling pipelines, reinforce couplings, repair damaged internal threads, or serve as keys in rotating machinery. Inserts are available in different forms like:

a. Keys in shaft key-ways
b. Threaded rod
c. Unthreaded rod
d. Helical threaded inserts
e. Keystock

Unit 2.3 - Plumbing Tools and Equipment

Unit Objectives

At the end of this Unit the trainee will be able to:

1. Identify various plumbing tools and equipment correctly
2. List the lifting/load shifting equipment including ladders, height scaffolding, elevated work platforms, hand trolleys, hoists and jacks used at plumbing installation sites

2.3.1 Different Types of Plumbing Tools and Equipment

A plumber needs a variety of tools and equipment to complete repair work, fix a tap, or perform fitting work. These devices enable a plumber to do their job well. Tools for plumbers should be used systematically. In order to prevent damage, tools should be handled carefully. After use, tools should be stored correctly. Tools can be categorized based on the type of task they are used for, such as holding, fitting, cutting, pipe threading, and bending tools, among others. The important tools used in plumbing are classified as:

Holding Tools	Fitting Tools	Cutting Tools	Pipe Bending Tools	Other Tools
• Bench Vice • Pipe Vice	• Wrenches • Spanners • Pliers	• Pipe Cutter • Hacksaw	• Pipe Bending Machine • Threading Dies	• Chisel • Hammer • Rover Jumper • Trowel • Screw Driver • File • Caulking Tools • Drill Machine • Drill Bit • Hangers • Measuring Tape

Fig 2.63 Plumbing Tools

1. Holding Tools

Holding tools are used for holding pipes, pipe fittings, and fixtures in plumbing operations. Some of the commonly used holding tools are mentioned below.

a) Bench Vice

A vice is a work-holding tool used for holding an item for various work like filing, chipping, sawing, threading, bending of various jobs, fitting, tapping, etc. The bench vice has two jaws, one of which is fixed and the other is moveable. These jaws are fitted with plates for gripping the job. The vice size depends on the width of the jaw. Bench Vice is fixed through a bolt to a

table or bench. Vice is opened and closed with the help of an attached handle to a spindle. In this way, the material is held tightly. Bench vices hold the objects and allow the use of other tools to complete a task.

b) Pipe Vice

A pipe vice is a tool used for holding a pipe for carrying out assembly, disassembly, threading, cutting, etc. The pipe vice is of two kinds:

I. Open side pipe vice

II. fixed side pipe vice

The pipe's vice sizes are known by the opened size of the jaws. Standard sizes of vices are from 80mm, 105 mm, 130 mm, 170 mm, etc.

Fig 2.64 Bench Vice
Source: Indiamart

Fig 2.65 Pipe Vice
Source: Indiamart

4. Fitting Tools

Tools that are used for carrying out various plumbing operations like cutting, tightening, fixing, and other small tasks are called fitting tools. Some of the commonly used fitting tools are mentioned below.

a) Wrenches

Wrenches are used to tighten and loosen nuts and bolts. For removing or reinstalling nuts and bolts, wrenches grasp tiny or slick ones. Adjustable and non-adjustable wrenches are the two most common types utilized. These are particularly helpful when dealing with nuts and bolts of unusual sizes. These devices allow you to screw or unscrew a pipe and pipe fittings. This is a highly popular instrument, particularly for pipes with a small diameter up to 50 mm.

Fig 2.66 Adjustable Wrench
Source: Indiamart

Adjustable wrenches are used to tighten or loosen nuts and bolts of all irregular and standard sizes. It is employed to tighten and loosen geysers, flexible pipes, cocks, and valves. It works well for maintaining and repairing plumbing components including valves, cocks, pumps, etc. It has a handle, a fixed flat jaw, and a square-toothed screw. With the aid of a screw, the movable flat jaw slips into the fixed jaw's body. The object that needs to be turned in order to screw or unscrew anything is held in the space between the flat jaws.

b) Water Pump Plier

Plumbers frequently use this type of plier to grip, tighten, and loosen work while fixing something. The material utilized to make water-pump pliers is steel. There is only one standard size of them, measuring 250 mm in length. The two jaws can be separated by a maximum of 40 mm.

Fig 2.67 Water Pump Plier
Source: Indiamart

c) Spanners

Spanners are used for tightening and loosening nuts and bolts of standard size. Different types of spanners are listed below:

I. **Ring Spanners:** At both ends of these spanners are entire, closed circles. It is challenging to slip and hurt yourself. It is forged, and either has a burnished finish or is chrome-plated.

II. **Open-ended Spanners:** These kinds of spanners are used to tighten and loosen nuts and bolts since they are open on both sides. The square or hexagonal-headed nut or bolt is passed through by a spanner with open-ended jaws. After that, the bolts or nuts are rotated with the necessary force to screw or unscrew them. The two jaws are two sizes that come after one another, such as 6 mm and 7 mm or 1/4" and 5/16", etc.

III. **Combination Spanners:** These spanners are open at one end and closed at the other.

IV **Bi-hexagonal Ring Spanner:** To handle a nut or bolt with a square or hexagonal bolt head, it has bi-hexagonal shapes at both ends. The two ends' sizes are sequential, such as 6 and 7 millimeters, 1/4 and 5/16 inches, etc.

Fig 2.68 Ring Spanners
Source: Indiamart

Fig 2.69 Open-ended Spanner
Source: Indiamart

Fig 2.70 Combination Spanner
Source: Indiamart

Fig 2.71 Bi-hexagonal Ring Spanner
Source: Indiamart

5. Cutting Tools

Cutting tools are used for cutting pipes, fixtures, and s, etc. Some of the commonly used cutting tools are listed below:

a) Pipe Cutter

When using a hacksaw frame is challenging, a pipe cutter is used to cut a pipe on the job site. For cutting a pipe, this tool has a pointed, round cutting wheel that rotates in a to-and-fro rotary motion.

b) Hacksaw

Typically, both hands are used to use this tool. It can cut materials like steel rod, plastic pipe, angle iron, sheets, and iron pipes. When nuts and bolts become stuck, it can also be used to cut their heads. A hacksaw's grip, frame, blade, and adjusting wing nut are all significant components. A power hacksaw is used in a workshop to quickly cut heavy pipes, whereas a hand-operated hacksaw is used for site work.

Fig 2.72 Pipe Cutter
Source: Indiamart

Fig 2.73 Hacksaw
Source: Indiamart

6. Pipe Bending Tools

In most plumbing operations, pipes are required to be bent at different angles as per requirement, for which pipe bending tools are used. Some of these tools are mentioned below.

a) Pipe Bending Machine

Pipes can be bent or turned using a pipe bending machine. The diameter of the pipe and the kind of pipe material to be bent determine the machine's size and strength. For pipes with a diameter of 3/8 to 1'', mechanical or manually operated pipe bending equipment is offered. Higher ranges, such as 1/2-2'', 1/2- 3'', 1/2- 4'', and 2- 6'', are covered by hydraulic hand-operated equipment.

Fig 2.74 Pipe Bending Machine
Source: Indiamart

b) Threading Dies

Effective pipe and fixture connection requires threading. To create threads in a pipe where it will be connected to another pipe or fixture, a threading die is used.

Fig 2.75 Threading Dies
Source: Indiamart

7. Other Tools

Various other tools are also used in plumbing operations apart from the already mentioned holding, fitting, cutting, and bending tools. The other tools used for plumbing operations are listed below.

a) Chisel

It is made of hard metal and is mostly used for cutting concrete surface and making grooves in the walls with the help of a hammer.

b) Hammer

These are all-purpose workshop hand tools used for keyway insertion and fitting by striking, riveting, riveting, striking of nails, and straightening of sections. The hammer has a wooden grip and a head made of strong, distorted steel. The opposing side of the head is referred to as pein and has a flat, striking face. The peins are categorized according to their various shapes, including ball, cross, and straight. Engineer's hammers are commonly used when working with steel components and are made of hardened steel.

c) Chain Wrench

When it comes to huge-diameter pipes, the usual holding tools are not very helpful. Chain wrenches are employed for these. A handle, a chain, and a toothed block make up a chain wrench. The chain is held on the toothed end of the block and is circular with grooves. The chain tightens or loosens the pipe fitting while holding onto it. The chain wrench comes in lengths of 3", 4", 6", 8", and 12", measuring 475, 585, 834, 1100, and 1360 mm, respectively. These sizes are indicated by the largest pipe diameter that they can accommodate.

d) Screw Driver

Plumbers frequently use this tool to tighten the screws. The pointed tip of a screwdriver may easily fit into a variety of screws. For various screw kinds, various screwdriver types are used. Plumbers employ a variety of screwdriver head types.

Fig 2.76 Chisels
Source: Indiamart

Fig 2.77 Hammers
Source: Indiamart

Fig 2.78 Chain Wrench
Source: Indiamart

Fig 2.79 Screw Drivers
Source: Indiamart

e) Files

Files are used for a range of tasks, including the removal of sharp edges, the removal of metal, the shaping of tasks, the smoothing out of surfaces, the finishing, the creation of various shapes, etc. Tang, heel, face, edge, and point or tip make up the five components of a file. Depending on the task, numerous types of files with various forms are employed, including hand round, pillar, square, three square, half round, flat, knife edge, and needle files.

f) Pliers

Pliers are used to tighten or loosen various elements as well as grasp small objects. A plumber uses a variety of pliers when working. Pliers can also be used to make cuts. Various sizes and shapes of pliers are available in the market.

g) Caulking Tools

Caulking tools are used to seal any holes in the wall. This device aids in adding and removing materials in the building.

h) Drill Machine

One of the common but crucial equipment used to drill a hole in a surface made of metal, wood, or concrete. A cutting instrument, such as a drill bit, is attached to a drill machine. A key is used to tighten the attachment.

Fig 2.80 Files
Source: Indiamart

Fig 2.81 Plier

Fig 2.82 Caulking Tools
Source: Pinterest

Fig 2.83 Drill Machine

l) Hangers

Pipe hangers are used to hold or support a pipe or a group of pipes from a slab, beam, ceiling, or other structural elements.

j) Measuring Tape

It is used to measure an object's length. Steel, fabric, and PVC are just a few of the materials used to make measuring tapes. The available lengths include one meter, two meters, three meters, five meters, 10 meters, fifteen meters, etc.

k) Plumb Bob

This is a practical tool to use while building walls, columns, and wooden window and door frames to ensure verticality and uniformity. Additionally, it aids in leveling the floor's surface. It is made up of a holding pipe, thread, and a metal and wood plumb bob. The thread is used to join the plumb bob to the holding pipe.

l) Spirit Level

It is used to check the horizontality or levelling of the floor, roof, door, window frame, etc.

Fig 2.84 Pipe Hanger
Source: Indiamart

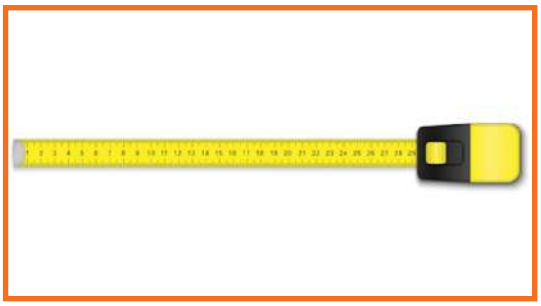


Fig 2.85 Measuring Tape

Fig 2.86 Plumb Bob
Source: Indiamart

Fig 2.87 Hammers
Source: Indiamart

m) Trowel

It is used for mixing cement and sand for masonry work. It is used for plastering the surface.

Fig 2.88 Trowel
Source: Indiamart

n) Spade

A spade is used to mix cement, sand, and concrete as well as for digging purposes. It is constructed up of a flat steel form with a hole for the wooden handle. A spade's size is determined by the length and width of the board.

o) Shovel

It is used for mixing concrete and also for carrying concrete to mortar pans. Shovels are made of steel sheets. The size is designated by its length and width.

p) Pickaxe

It is made of steel and is used to excavate hard soil. One end of the pickaxe is flat whereas, the other end is sharp in design.

q) Mortar Pan

This is used to carry concrete, cement mortar, and other excavated materials. Never use it to measure cement mortar that has been mixed, etc. For the construction of mortar pans, mild steel sheet is employed.

Fig 2.89 Spade
Source: Indiamart

Fig 2.90 Shovel

Fig 2.91 Pickaxe
Source: Indiamart

Fig 2.92 Mortar Pan
Source: Indiamart

r) Mason's square

It is used to check if the internal and external corners are rectangular. It is built of sheet carbon steel. Additionally, the dimension is marked on both sides in either an inch or a centimeter.

s) Water level tube

Water level tubes are used to check and transfer water levels, among other things. When using the tube, water is put inside of it. Polythene tubes with diameters ranging from 10 to 15 mm and lengths varied according to the need.

t) Rover Jumper

It is used for making a gap in the wall so that plumbing fixtures can be fixed.

Fig 2.93 Mason's Square
Source: Indiamart

Fig 2.94 Water level tube
Source: Indiamart

Fig 2.95 Rover Jumper
Source: Indiamart

7. Lifting/Load shifting equipment

Following are the list of lifting /load shifting equipment used at plumbing installation sites:

a) Ladder

Ladders are required frequently in plumbing sites for having access to a platform (working for a relatively short period of time).

b) Scaffoldings

These are relatively used for the same purpose as of ladder but generally laid where longer duration of work is to be done. As for long duration, ladder founds to be unsuitable. To get access to heights, these work to be the best option. Unsafe scaffolding can lead to major injuries and even deaths too.

c) Hand Trolley

Hand trolleys is a small transporting device which is used to move heaving loads from one place to another. This is one of very commonly used tools in different industries and sites.

Fig 2.89 Ladder

Fig 2.90 Scaffolding
Source: Indiamart

Fig 2.95 Rover Jumper
Source: https://www.tradeindia.com/products/metal-manual-hand-trolley-6162119.html

d) Hoists

This is a device used for lifting or lowering a load by means of a drum or lift-wheel around which rope or chain wraps. It can be operated manually, electrically or pneumatically or one can use a chain, fiber or wire rope as its lifting medium.

e) Jacks

Another tool that is used to lift heavy loads is jacks. Such as in a hydraulic jack, hydraulic power is used. Most commonly used is car jack, floor jack etc.

Fig 2.92 Hoist
Source: Indiamart

Fig 2.93 Jacks
Source: https://www.hawkcrawlspaceandfoundationrepair.com/crawl-space-jack-installation-in-chesapeake-va

Notes

Unit 2.4 - Properties of Water

Unit Objectives

At the end of this Unit the trainee will be able to:

1. Explain the properties of water, including pressure and flow rates. Describe processes such as capillary action and thermal expansion in plumbing.

2.4.1 Various Properties of Water

Water is a "Universal solvent" as it can dissolve a greater number of substances than any other substance. It is the only common substance to exist as solid, liquid and gaseous form. Following are properties of water:

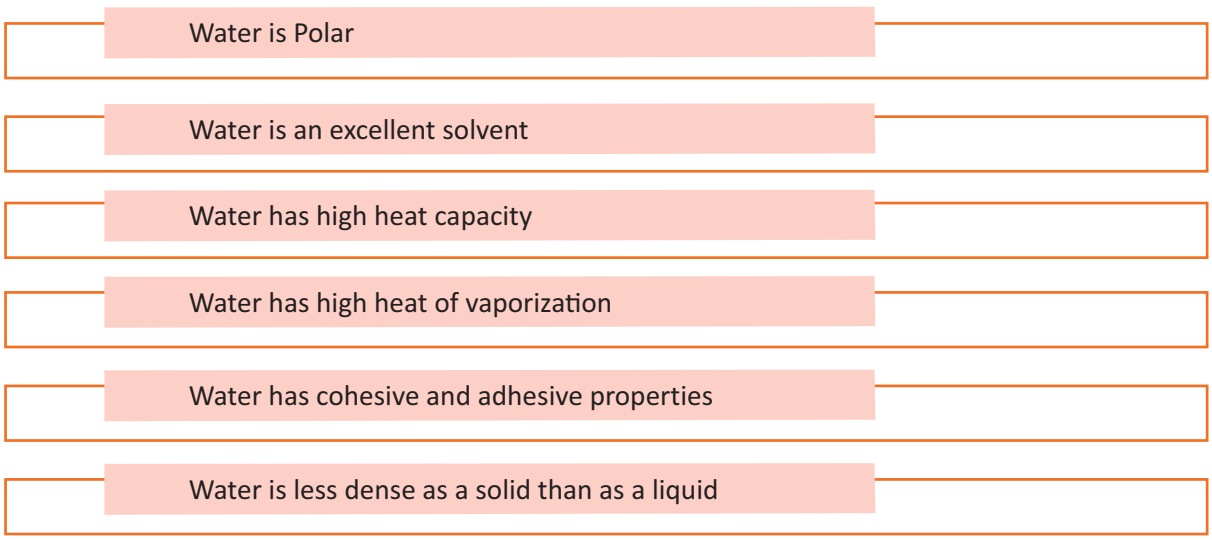


Fig 2.94 Properties of Water

1. **Water is Polar**

   The structure of water molecules is twisted and polar, with partial positive charges on the hydrogens and partial negative charges on the oxygen. This is because oxygen attracts electrons more effectively than hydrogen since it is more electronegative.

2. **Excellent Solvent**

   Many polar and ionic chemicals can be dissolved by water, which is a unique property of water. All living creatures need to know this since the water cycle removes many critical nutrients from the water as it moves through it.

3. **High Heat Capacity**

   Water aids in controlling environmental temperature since it takes a lot of energy to raise the temperature of a specific volume of water by one degree. This characteristic, for instance, enables the temperature of water in a pond to largely remain consistent from day to night despite fluctuating ambient temperatures.

4. **High Heat of Vaporization**

   Humans and other sweating animals use the high heat of vaporization of water to cool themselves. When the temperature for vaporization is attained, water changes from its liquid state to steam. Because perspiration is primarily composed of water, as it evaporates, it collects extra body heat that would otherwise be discharged into the atmosphere which is known as evaporative cooling.

5. **Cohesive and Adhesive**

   Water molecules can create hydrogen bonds with one another, since they have powerful adhesive forces. Surface tension, or the propensity of a liquid's surface to resist rupture when subjected to tension or stress, is caused by cohesive forces. Water may adhere to objects other than itself thanks to its adhesive qualities as well. In many forms of life, these cohesive and adhesive qualities are crucial for fluid transfer. For instance, they enable nutrients to be carried up a tree's trunk in defiance of gravity.

6. **Less dense as a solid than as a liquid**

   When water freezes, the molecules organise into a crystalline structure that spreads them farther apart than when the water is liquid. As a result, ice floats because it is less thick than liquid water. This characteristic is crucial because it prevents ponds, lakes, and oceans from freezing over completely and enables life to persist beneath the cold surface.

2.4.2 Capillary action

It can be defined as the “Ability of a liquid to move against gravity through the close gap between the two surfaces”.

For example - If the plumber adds no sealant between the flashings in ceilings while installing them, it can damage a large amount in the ceiling too as due to capillary action will take place and water will come out from above as well. Hence it must be taken care of.

2.4.3 Thermal Expansion

An increase in temperature leads to the expansion of water, this phenomenon is known as Thermal expansion. It generally occurs in all plumbing systems having tank-type water heaters. It will lead to high water pressure and so cause expensive problems. Hence previous to tank-type water heaters, plumbers used to put an adjustable pressure relief valve in the system. For more safety, the expansion tank and relief valve both must be installed at the same time.

Summary

- Plumbing is defined as a system of pipes and fixtures installed in a building used for supplying water and removing the used water and waterborne wastes. Every home and building must have a plumbing and sanitary system.
- A trained plumber does the installation of the fittings and fixtures as per the drawing provided in the assembly sheet of the plumbing fixture in the manufactures catalog. Identification of the symbol given in the drawing in the fixtures makes the installation work easy for a plumber.
- Airgap is the distance between the lowest point of a water inlet or pipe to a tank and the overflowing level of the tank
- A plumber needs to be proficient at measuring plumbing supplies with the aid of measuring instruments and have no trouble handling unit conversions.
- The plumbing system in a building distributes water for drinking, heating, and washing, as well as for the removal of waterborne wastes. It consists of pipes, drain fittings, valves, valve assemblies, and devices.
- Cast Iron Pipe is used as a pressure pipe for transmission of water, gas and sewage, and as a water drainage pipe.
- In pipe plumbing systems, fittings are used to join straight pipe or tubing pieces, to adapt to various sizes or forms, as well as for additional uses like regulating or metering fluid flow.
- A pipe fitting in the form of a sleeve for jointing the spigot ends of two pipes in the same alignment is known as a collar.
- An elbow is a pipe fitting used to provide a change in direction, often a 90° or 45° angle, between two lengths of pipe or tubing.
- Gaskets or Mechanical seals are used to seal flange joints. It comes in a variety of designs, compositions, and features.
- Couplings are used to connect two pipes to each other. If the pipe sizes are different, the fitting may be referred to as an adapter, a reducing coupling, or both.
- A reducer is used for a change in pipe size to meet hydraulic flow requirements of the system.
- A tee is used to combine (or split) fluid flow. It is offered with a female-threaded side outlet, opposing solvent-weld sockets, or female thread sockets.
- Joints are used to attach pipes together. The assembling of pipes uses a variety of joints. Fitting refers to the process of joining two or more pipes together.
- The water supply mains use brass or iron valves to ensure good pipeline operation. The flow of fluids such as liquid, gas, condensate, etc. is stopped or controlled by valves.
- A plumbing fixture is a component that connects to the building's plumbing system and transports water. Showers, tubs, sinks, faucets, and bathtubs are the most popular plumbing fixtures.
- A fastener is any one of a large variety of mechanical tools or components that are used to rigidly attach two or more items to one another.
- A plumber needs a variety of tools and equipment to complete repair work, fix a tap, or perform fitting work. Tools can be categorized based on the type of task they are used for, such as holding, fitting, cutting, pipe threading, and bending tools, among others.

Exercise

1. Match the following

S. No	Symbol	Symbol Name
1.		Straight Tee
2.		P-Trap
3.		90° Elbow
4.		Gate Valve
5.		Sanitary Tee

2. List any three materials used for manufacturing pipes.

3. List any three Plumbing fixtures and their purpose.

4. List any three Plumbing fixtures and their purpose.

5. List any three Plumbing tools and their purpose.

Notes

QR Code

Scan the QR Code to watch the related video

https://youtu.be/wpQD4XzjKDM
Process of Mains Supply of Water and Drainage

https://youtu.be/1YQ9dpa6_lw
Pipe Materials

https://youtu.be/GfNUaVFmxaY
Different Types of Plumbing Tools and Equipment

https://youtu.be/q33WAVm0K5o
Various Pipe Fit-Off Processes

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
National
Skill Development
Corporation
Transforming the skill landscape

3. Preparation for plumbing installations and maintenance

WATER MANAGEMENT AND PLUMBING SKILL COUNCIL

Unit 3.1 - Plumbing Drawings

Unit 3.2 - Handling of Plumbing Materials

PSC/N0130

Key Learning Outcomes

At the en d of this module, the trainee will be able to:

1. Perform the steps involved in planning and preparation of plumbing work

Unit 3.1 - Plumbing Drawings

Unit Objectives

At the end of this Unit the trainee will be able to:

1. Explain the types and purpose of plumbing drawings
2. Discuss the purpose of work schedules, work plans, charts, work bulletins, memos and the work-related information that can be obtained from them
3. Describe the steps involved in collection of plumbing materials as per type, size and quantities based on specifications from drawings and plans

3.1.1 Introduction to Plumbing Drawings

A plumbing drawing is a specific kind of technical drawing that offers information and a visual depiction of a plumbing system. It is utilized to communicate the engineering design to plumbers or other employees who will use them to assist with the plumbing system installation. A plumbing drawing is used to clearly represent the locations of fixtures, sanitaryware, piping, valves, and other components, as well as to demonstrate how wastewater is to be collected and how fresh water is to be provided to a facility. The pipe runs are typically colored red and blue, respectively, to show the distinct hot and cold-water supplies. The grade (slope) should be shown on drainage pipe illustrations. A manhole schedule should include information about the name, invert level, cover level, and depth of any manholes that are present. A plumber has to read and understand the plumbing drawing before starting the work.

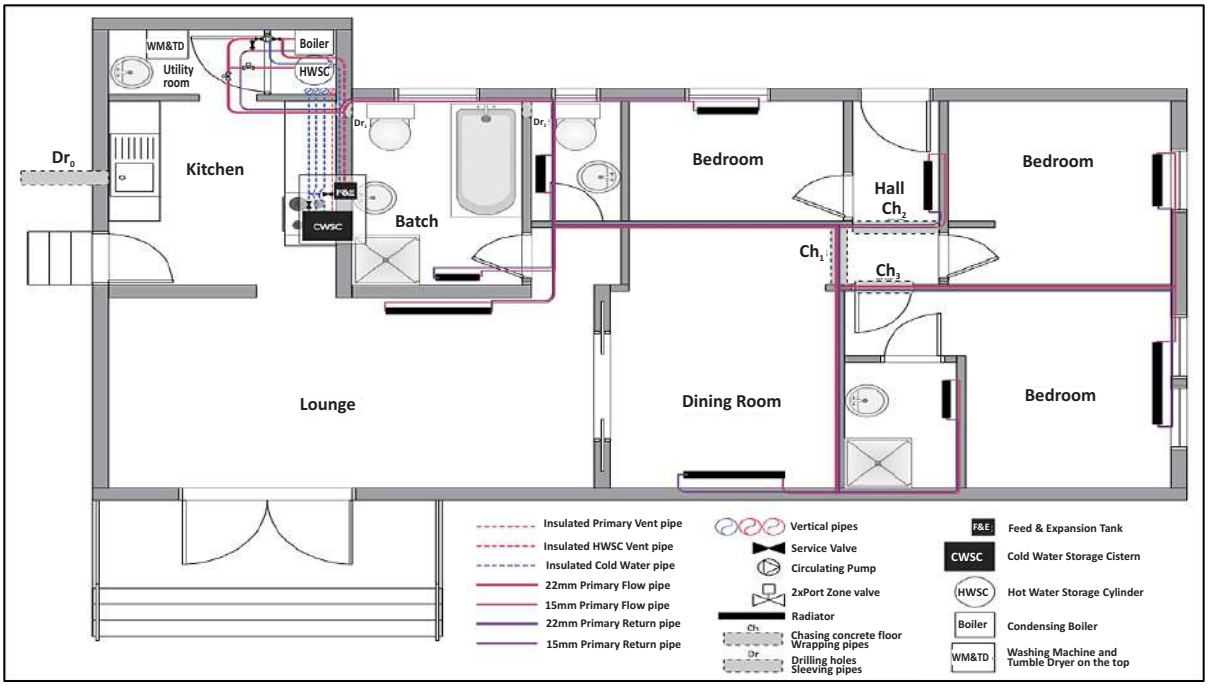


Fig 3.1 Typical Plumbing Drawing

Source : https://www.conceptdraw.com/examples/residential-plumbing-plan-drawings

Purpose of Plumbing Drawing

- A plumbing drawing helps the plumber to understand clearly the location of fixtures, sanitaryware, pipework, valves, and so on, and it illustrates how fresh water is to be supplied into a building and wastewater removed.
- It helps in quantity calculation, planning, execution, checking of wastages, and maintenance of plumbing works.
- A plumber may visualize any practical difficulties in carrying out the work as shown in the plumbing drawing and make the necessary changes, during the initial planning stage.
- With the help of these drawings, the plumber understands the work to be carried out for a building project.

Different types of plumbing drawings are:

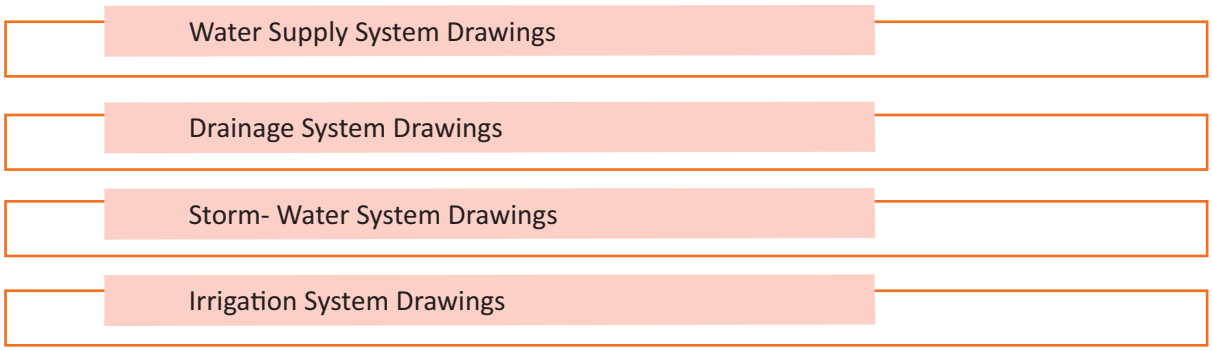


Fig 3.2 Types of Plumbing Drawings

1. **Water Supply System Drawings**
   - In the water supply system drawings, the respective pump capacity and the number of pumps used must be stated in the drawing file. The water supply system drawings include the following:
     I. Hot water piping
     II. Cold Water Piping
     III. Hot water return piping system
2. **Drainage System Drawings**

   In drainage drawings, the manhole schedule must be shown. A manhole schedule consists of the manhole name, invert level, cover level, and depth, which are clearly specified in the drawing. The drainage system drawings include:

   I. Waste Piping
   II. Soil Piping
   III. Vent Piping
3. **Storm-Water System Drawings**

   A stormwater system is a system that is built in order to manage the water coming from rainfall and runoff.

3. Storm-Water System Drawings

A stormwater system is a system that is built in order to manage the water coming from rainfall and runoff.

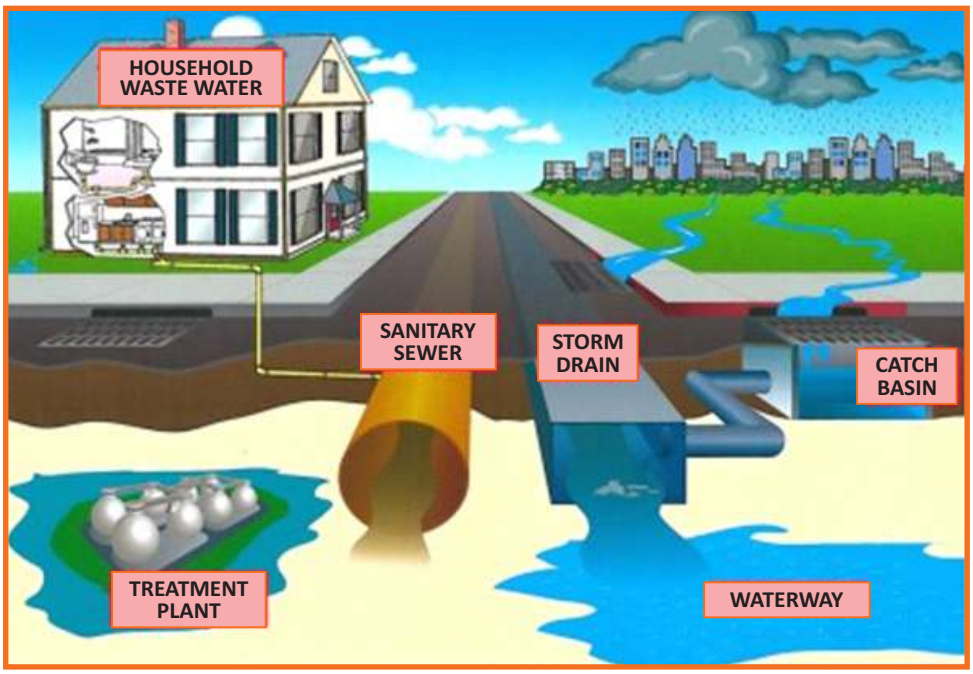


Fig 3.3 Stormwater Drainage System

Source: https://www.deeptrekker.com/resources/storm-water

4. Irrigation System Drawings

An irrigation system is a method of artificially supplying water to conduct irrigation through canals, dams etc.

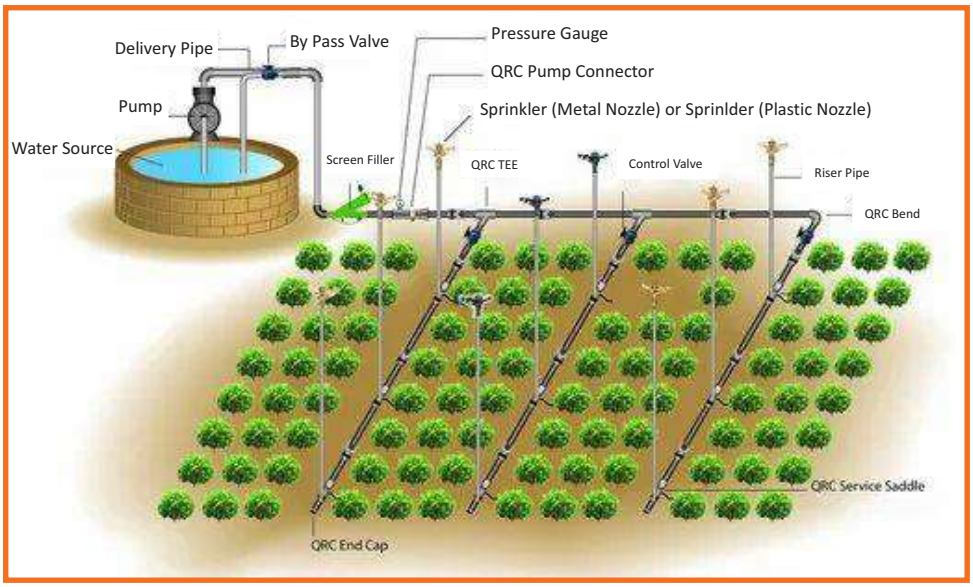


Fig 3.4 Irrigation System

Source : https://www.indiamart.com/proddetail/sprinkler-irrigation-system-20573851433.html

3.1.2 Work Schedules

For effective and timely completion of work, a work schedule is to be planned. The meaning of a work schedule is to calculate the days and times that a person is expected to do the work. A work schedule is a plan by managers or contractors in which they clearly mention the number of days and hours to be worked.

1. **Work plan**
   - For carrying out the work effectively a work plan is to be prepared. A work plan is a written document made to make a project run more smoothly. The goal is to produce a visual reference for the mission, duties, objectives, and team members in charge of each region. Every member of the team is updated based on progress and current status. The team of plumbers will be completing his work as per the work plan.
   - A thorough work plan is key to the success of any project. This step-by-step guide will help you create the perfect work plan for your team.
2. **Chart**
   - It is necessary to use charts to better communicate and show your achievements. With the help of a chart, various performance parameters of employees are conveyed. Any employee can see his/her performance through the chart. Charts are prepared for various activities as mentioned below:

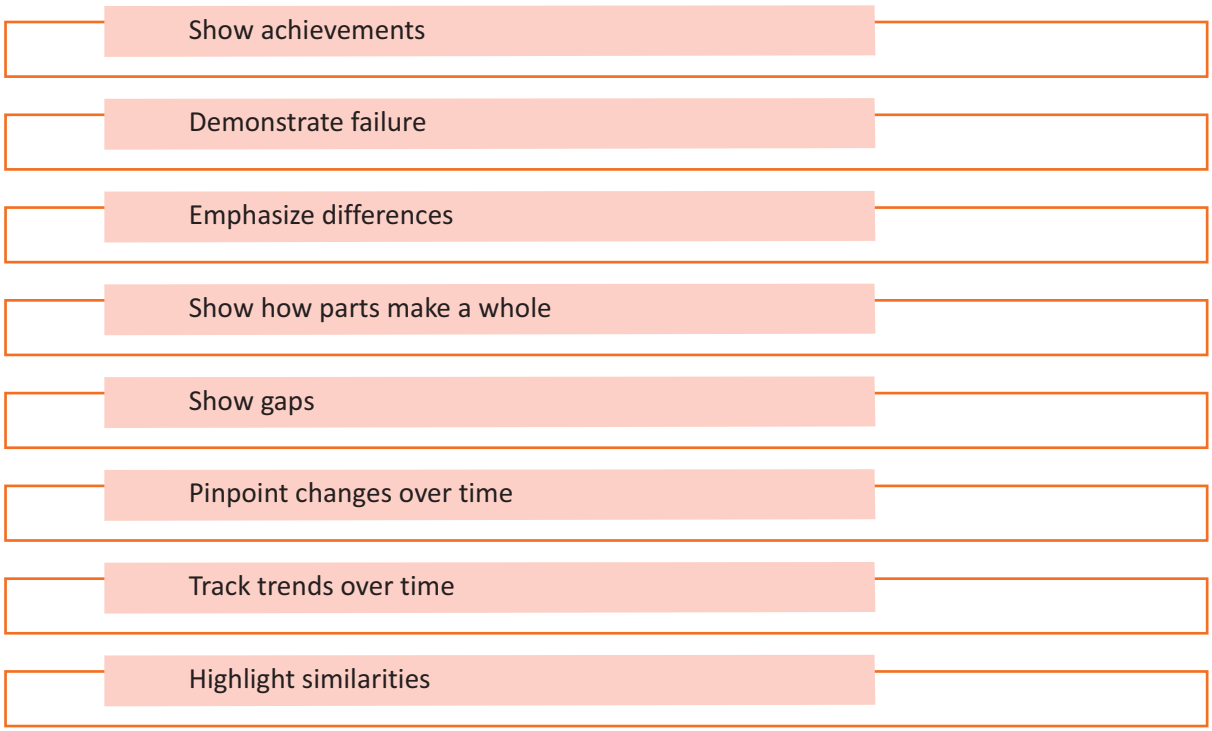


Fig 3.5 Various Chart Parameters

3. **Work Bulletin**

   The purpose of the work bulletin is to create a sense of community within the workplace and to keep team members engaged. Team or staff bulletin boards are other names for office bulletin boards. These boards help to enhance company culture and encourage employee engagement. In the work bulletin, things like motivational quotes, employee birthdays, and pictures are shown on one side. Other things like monthly event schedules, newsletters, and operations information and reminders are shown on the other side.

4. **Memo**

A memo or memorandum is a message used within a company to convey information. Memos can be utilized to notify people of new policies, remind staff members of current guidelines, and generally keep them informed. A memo can be used to communicate with people outside of an organisation because it is less formal than a letter. Memos serve two purposes: they draw attention to problems and they help to find solutions. They achieve their objectives by alerting the reader of new information, such as price rises or changes in policy, or by convincing the reader to take a specific action, such as attending a meeting or altering an existing production technique.

5. **Work-Related Information**

Before beginning the work, any plumber or employee who has been hired for a specific task is provided with all the necessary information. The employee is notified of all work-related information, such as job descriptions, pay scales, supervisors, and service policies. Employees must adhere to the regulations correctly in order to foster a positive work environment. He could be subject to disciplinary action if the regulations are not followed correctly.

3.1.3 Collection of Plumbing Materials

A plumber should be able to read and understand the plumbing drawings and plan carefully. The plumber should discuss the drawing details with his supervisor or contractor for more clarity. Steps involved in the collection of plumbing materials as per type, size, and quantities are explained below:

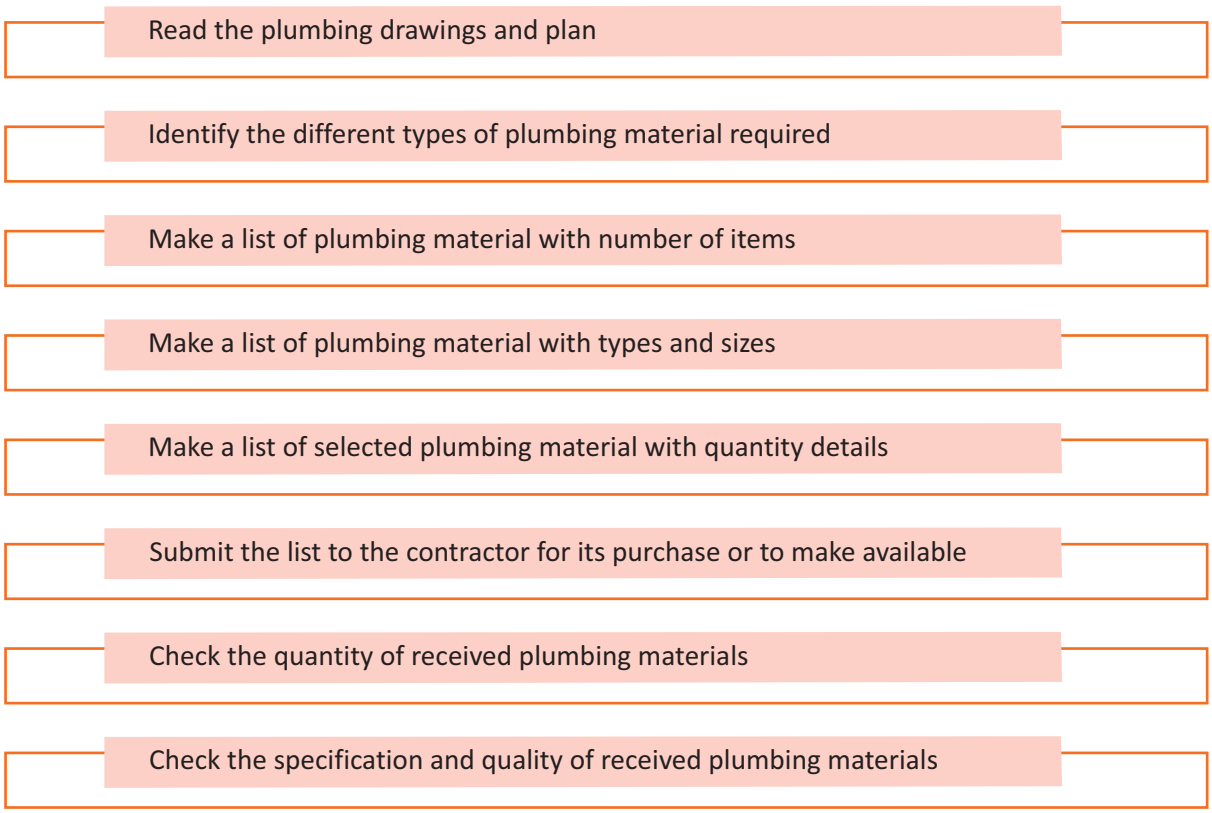


Fig 3.6 Steps involved in the collection of plumbing materials

Unit 3.2 - Handling of Plumbing Materials

Unit Objectives

At the end of this Unit the trainee will be able to:

1. Explain the factors to be kept in mind for safe handling, storage and transport of various plumbing materials
2. List measures to avoid air and water contamination, erosion and sedimentation
3. Discuss the risk and impact of not following defined procedures/work instructions
4. Outline the process of reporting and handling hazards at the workplace

3.2.1 Safe Handling of Hand Tools and Power Tools

As a plumber, it is necessary to use our plumbing tools, equipment, and plumbing material properly in a workplace and storage unit. These materials should be kept in an organized way and in a safe and secure location. This means that they should be away from any areas where they could be damaged or contaminated. Second, one should ensure that the materials are easily accessible. Materials should be kept on shelves. Similarly, shelves and racks should be sturdy and in good condition. Stacking of all materials should be done on a flat base. heavier objects should be placed closer to the floor and lighter/smaller objects at a higher level.

Plumbing tools and materials should be used safely so that no injury is made. Handling of tools and materials should be done as per the standard procedure. All safety precautions should be adopted in the handling of tools. Plumbing materials should be properly packed and transported safely so that it does not get damaged. A standard transport facility should be used for transporting the plumbing materials.

Fig 3.7 Box for Storage and Transportation of Plumbing Tools

Source : https://gibadi.com/products/knipex-l-boxx%C2%AE-sanitar

3.2.2 Safe use of Plumbing Tools

The following safety measures may be taken for the safe use of the plumbing tools:

- Use the tools as per the instructions mentioned in the manual
- Use appropriate tools for specific tasks
- Perform regualar maintenance of tools
- Follow proper safety measures while using electrical wires
- Wear appropriate Personal Protective Equipment
- Use kerosine to remove dust from rusty nuts
- Do not use damaged tools
- Remove burrs or stuck material from the edges of tools
- Lubricate the tools properly
- Do not apply excessive pressure or force on tools

Fig 3.8 Safety Measures for Using Plumbing Tools

3.2.3 Safety Measures to Avoid Contamination

When a plumber comes in contact with polluted air and water during plumbing work, various types of infection may take place. Different types of contamination in plumbing are explained below:

I. Air Contamination

The presence of pollutants in the atmosphere that is damaging to both human health and the health of other living things is referred to as air pollution. The climate of the earth is negatively impacted by air pollution, which frequently makes natural disasters like drought and flooding worse.

II. Water Contamination

The term "water pollution" refers to the contamination of water bodies, typically as a result of human activity. In addition to groundwater and aquifers, affected water bodies might also include lakes, rivers, and seas. It may have a deleterious effect on aquatic ecosystems, which may then have an effect on people and other organisms that depend on the body of water. The major causes of water contamination are listed below:

- The tap water's original source, which may have been a river, lake, groundwater, aquifer, or seawater (desalinated), may have had nitrates, bacteria, microplastics, medicines, and hundreds of other contaminants, depending on the source.

- The facility or service that treats water using chemicals like chlorine or chloramine and occasionally modifies its characteristics (softening, pH, sulfates, etc.) and where, in general, all regulated substances have been lowered to "safe" levels. For example, Lead, copper, and zinc flakes can come from pipelines, pipes in homes, connections, or faucets.
- From local water tanks or pipes, where water remains for a long time and may cause the growth of germs.
- From water filters that have not been changed out on schedule (e.g., bacteria, contaminants that get released, or filter elements that get released such as activated carbon)

III. Erosion

Pipe erosion and corrosion are rather typical. It occurs over time due to the materials of the pipe, the acidity of the water, the temperature of the fluid passing through the pipe, as well as the velocity and pressure of the fluid. Regular pipe evaluations and inspections can assist find signs of pipe erosion before it leads to serious pipe failures. The major causes of pipe erosion are listed below:

- Material of the pipe
- Acidic water
- Water temperature
- Water pressure and velocity
- Failure to Install Dielectric Unions

The pipe erosion can be prevented by the following procedures:

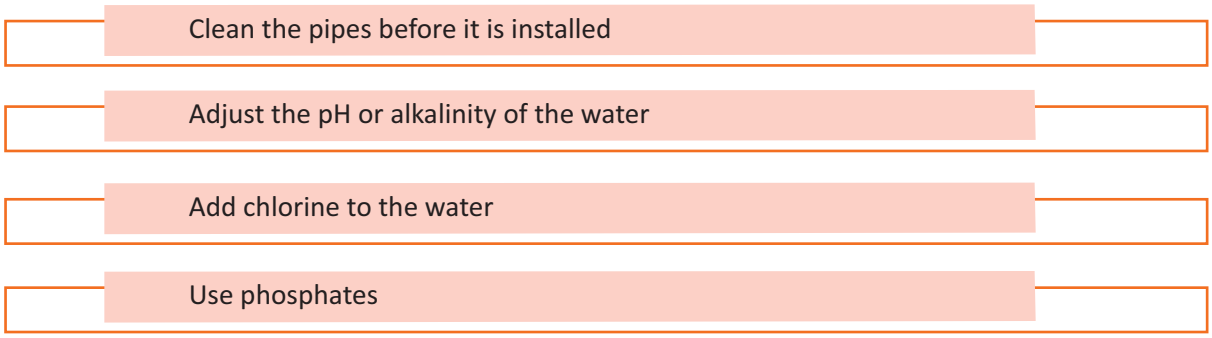


Fig 3.9 Prevention of Erosion

a) Cleaning Pre-Installation

Pre-installation cleaning of the piping before installation is one of the more efficient strategies to stop water corrosion. By doing so, any debris is removed, and the pipe system's lifespan is greatly extended. The lifetime of the piping is also increased by adding a cleaning agent. Flushing the system until the water is clear helps with this process.

b) Adjusting the Alkalinity

Adjusting the pH or alkalinity of the water is one of the best strategies to stop water corrosion in piping. Using an experienced business will enable you to do this safely. Acid rain and the minerals in the local rocks may both contribute to the acidity of the water. Filtering and adding safe chemicals to the water supply can modify the pH to stop corrosion. But it does make the water in that location harder.

c) Adding Chlorine to Water

The microbial pollution of the supply is one of the main issues causing water corrosion. An efficient technique to maintain water safety and stop water corrosion, which causes further issues in a municipal supply, is to add chlorine to the water supply. Chlorine is well known for its ability to disinfect and is successful in eradicating bacterial issues. Professionals must perform water treatments like chlorination because if done improperly, they can have negative consequences like an increase in corrosion.

d) Using Phosphates

Sometimes phosphates are added to water supplies to stop corrosion. They serve as a corrosion inhibitor to stop metals from copper and lead piping from leaching. Insoluble protective mineral scale layer is created on the interior of service pipes and home water lines when inorganic phosphates are supplied to the water supply. This prevents water corrosion in the pipelines. When compared to the average adult diet, the amount of phosphate in water is incredibly low. Phosphates and other chemical water treatments must be handled by experts who have the knowledge to determine the kind of treatment that is best for a location.

IV. Sedimentation

Sedimentation is the process of separating tiny particles and sediments from water. When the water is quiet, gravity will naturally cause the heavier sediments to fall to the bottom and form a sludge layer. In the water treatment process, this activity can be artificially induced. To lower the concentration of particles in the water, sedimentation is used. Sedimentation has the benefit of reducing the necessity for coagulation and flocculation. Usually, chemicals are required for flocculation and coagulation; however, with enhanced sedimentation, this requirement can be reduced. Additionally, sedimentation can be applied following coagulation to improve the process' continuous filtering.

Additionally, to avoid contamination, the following measures may be taken by the plumber:

- Wear the mask on nose
- Use the hand gloves
- Wear the plumber helmet or cap during plumbing work
- Use vacuum cleaner to clean the polluted water
- Keep contaminated material in sealed container
- Drill the wall or surface slowly
- Collect the sedimented material in a container
- Clean the surface after plumbing work
- Clean the tools and equipment after its use
- Place the plumbing tools and equipment safely after use

Fig 3.10 Safety Measures for Avoid Contamination

3.2.4 Consequences of not Following Work Instructions

Procedures are important because they ensure safety and efficiency. They also provide a framework for accountability. Without them, things can go wrong very easily. This can cause problems. Similarly, work instructions should be followed by technicians. Defined procedures/work instructions given by the employer should be properly implemented by the plumber or technician. Non-following the procedure will disturb the efficiency of the work to be done. When a person does not follow the defined procedure at work, there is a chance of accident and risk. It is necessary to follow the standard procedure while operating any tools or machinery. All safety precautions must be taken while handling the tools or machines. Work instructions are a detailed set of instructions given to any employee or technician to carry out the assigned work including safety rules to be followed. These safety rules may be related to the risk of fire, poisoning, or falling.

Depending on the circumstance, work instructions may also be referred to as work guides, Standard Operating Procedures (SOPs), job aids, or user manuals. In any event, the aim of work instructions is to precisely describe how a specific work assignment is carried out. They're like step-by-step instructions for performing a specific task. Such as, when we learn to drive a car: check gear stick is in neutral, start ignition, press clutch, change to first gear, and so forth. The importance is that work instructions should not be confused with processes or process maps.

Here given are work instructions that fit into our overall process documentation levels:

Process Hierarchy	A process hierarchy shows your overall process architecture and how it supports your business
Process	A process is a chain of activities that transform inputs to outputs
Procedure	A procedure outlines how to perform a process – sequence and who does what
Work Instruction	A work instruction – or work guide, job aid or standard operating procedure – describes in detail how an activity within a process (or procedure) is performed.

Fig 3.11 Work Instructions

Notes

3.2.5 Reporting and Handling Hazards at the Workplace

Any workplace hazards should be reported right once to management, the safety division, or a supervisor. This is a standard practice that should exist in any workplace and every employee should be made aware that this is the appropriate action to take should they encounter any hazard or potential hazard they discover. Designing, setting up, and communicating a Hazard Reporting Program is a good idea to help avoid this potentially dangerous attitude. Implementing a Hazard Reporting Program will help ensure that your workplace is safer for the employees.

The workforce must be trained for hazard reporting keeping the following points in mind -

I. What is an unsafe condition and act that is to be reported?

II. When should a hazard is reported?

III. What should the workforce expect after a hazard is reported?

The general process of reporting hazards and their investigation at the workplace is given below -

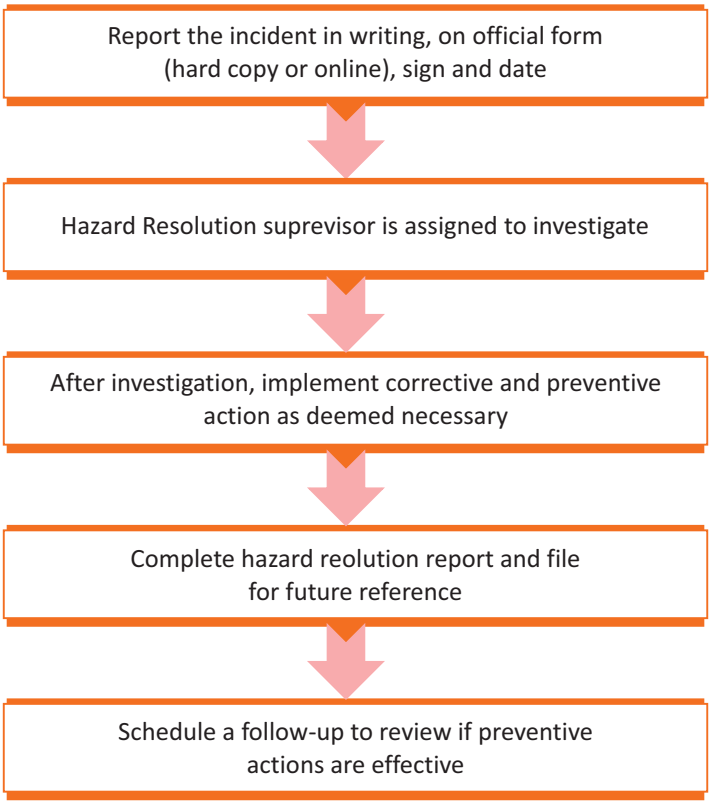


Fig 3.12 Process of Reporting Hazards

Following are some great ways to improve the quality of hazard reporting in your safety program-

1. Make reporting as easy as possible.
2. Ensure there is no negative stigma and no punishment attached to hazard reporting.
3. Give recognition to those who submit hazard reports.
4. Engage workers in the resolution of hazards to ensure the correction is satisfactory for all involved and does not create additional hardships inadvertently.
5. Keep an open discussion about safety issues, perhaps following up on the specific hazard reported at the next safety meeting.
6. Post signs or posters around the workplace that reinforces the message that unsafe conditions and acts must be reported.

Hazard in the Workplace

Workplace hazards are hazards that can cause harm, damage, or adverse health effects to the worker. The best way to prevent injuries or illness in your workplace is to find the hazards that could cause injury or illness, and fix them. Do this by following four simple steps:

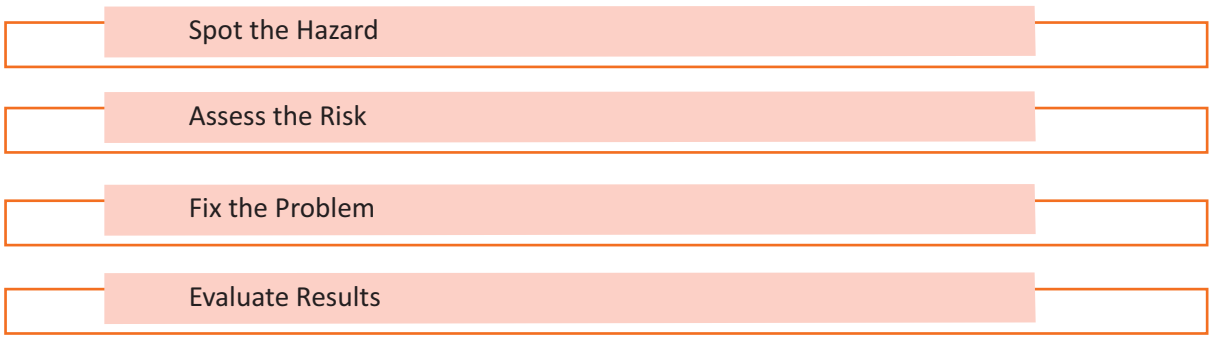


Fig 3.13 Risk Assessment Process

1. Spot the Hazard

A hazard is anything that has the potential to cause injury, illness, or damage to one's health. Hazards at work may include manual tasks, working at heights, chemicals, noise, poor work design, inadequate management systems (for example, no procedures for performing tasks safely or for using personal protective equipment), etc.

The first step in ensuring a safe workplace is to identify hazards. There are a number of ways to find hazards in the workplace:

- Ask workers and contractors in the workplace about any hazards they may have noticed.
- Checking the physical structure of the place itself such as stairs, doors, appliances such as fans, coolers, etc.
- Check all machinery, appliances, and vehicles used for work.
- Reviewing all the injury records.

A checklist must be prepared to examine the work environment, the tasks workers do, and the machinery/equipment used in the workplace.

2. Assess the risk

A risk is the likelihood of a hazard causing injury, illness, or damage to your health. The list of hazards may be long, with some posing more safety risks than others. On the basis of priority, it must be handled. The following aspects must be kept in mind for prioritization of the hazard:

I. Potential impact of the hazard

II. Is it can happen anytime or rarely?

III. How likely is the hazard to cause harm?

3. Fix the problem

It must be ensured that the hazard is completely removed from the workplace. If this doesn't sound possible then an alternative for it must be found. Some problems may be fixed easily and straight away, while others will need more effort and planning. Concentrate on the most urgent hazards without neglecting the simpler ones that could be easily and immediately fixed.

The following must be practiced for fixing the problem shown priority-wise:

I. Eliminate the hazard: Remove it completely from your workplace. For example- repair damaged equipment; outsource processes involving hazardous chemicals or equipment to a company set up to manage them safely.

II. Substitute the hazard: If elimination of a hazard is not possible then replace it with a safer alternative.

III. Isolate the hazard: If the above is not possible then, keeping away the hazardous substance from the workforce must be ensured.

IV. Using engineering tools: If isolation is not possible, adapt tools or equipment to reduce the risk.

V. Using administrative controls: If any of the above is not possible then one can switch to altering administrative controls. Changing work practices and organization can be done. Like, training staff in safe work procedures; carrying out routine maintenance of equipment, etc.

VI. Use personal protective equipment (PPE)

4. Evaluate results

After fixing the problem, find out whether the changes have been effective. Get feedback from those affected by the changes and include them in any modifications to their workplace or work routines. Make sure your solution does not introduce new hazards.

During each of these four steps, employers, managers, contractors, and workers need to communicate with each other and work together. As Hazard management is not a one-off event — it's an ongoing process.

Notes

Summary

- A plumbing drawing is a specific kind of technical drawing that offers information and a visual depiction of a plumbing system.
- Plumbing drawing helps the plumber to understand clearly the location of fixtures, sanitaryware, pipework, valves, and so on, and it illustrates how fresh water is to be supplied into a building and wastewater removed.
- A plumber may visualize any practical difficulties in carrying out the work as shown in the plumbing drawing and make the necessary changes, during the initial planning stage.
- A stormwater system is a system that is built in order to manage the water coming from rainfall and runoff.
- An irrigation system is a method of artificially supplying water to conduct irrigation through canals, dams, etc.
- For effective and timely completion of work, a work schedule is to be planned. The meaning of a work schedule is to calculate the days and times that a person is expected to do the work.
- The purpose of the work bulletin is to create a sense of community within the workplace and to keep team members engaged.
- A memo or memorandum is a message used within a company to convey information. Memos can be utilized to notify people of new policies, remind staff members of current guidelines, and generally keep them informed.
- As a plumber, it is necessary to use our plumbing tools, equipment, and plumbing material properly in a workplace and storage unit.
- When a plumber comes in contact with polluted air and water during plumbing work, various types of infection may take place.
- Pipe erosion and corrosion are rather typical. It occurs over time due to the materials of the pipe, the acidity of the water, the temperature of the fluid passing through the pipe, as well as the velocity and pressure of the fluid.
- Adjusting the pH or alkalinity of the water is one of the best strategies to stop water corrosion in piping.
- Sedimentation is the process of separating tiny particles and sediments from water. When the water is quiet, gravity will naturally cause the heavier sediments to fall to the bottom and form a sludge layer.
- Procedures are important because they ensure safety and efficiency. They also provide a framework for accountability. Without them, things can go wrong very easily.
- Any workplace hazards should be reported right once to management, the safety division, or a supervisor.
- Workplace hazards are hazards that can cause harm, damage, or adverse health effects to the worker.
- A hazard is anything that has the potential to cause injury, illness, or damage to one's health. Hazards at work may include manual tasks, working at heights, chemicals, noise, poor work design, inadequate management systems.

Exercise

1. What is meant by plumbing drawing?

_____

_____

_____

2. List different types of plumbing drawings?

_____

_____

_____

3. List the safety measures for the safe use of the plumbing tools.

_____

_____

_____

4. What are the prevention measures to control pipe erosion?

_____

_____

_____

QR Code

Scan the QR Code to watch the related video

https://youtu.be/AI9YIy-86v8
Safe use of Plumbing Tools

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WATER MANAGEMENT AND PLUMBING SKILL COUNCIL

4. Installation of Water Supply Systems

Unit 4.1 - Water Distribution System

Unit 4.2 - Installation Process

Unit 4.3 - Testing Procedures

PSC/N0131

Key Learning Outcomes

At the end of this module, the trainee will be able to:

1. Demonstrate the process of cutting, bending and assembling various types of water supply pipes
2. Perform the installation of the assembled pipes, fittings and other water supply components
3. Perform post-installation activities

UNIT 4.1 - Water Distribution System

Unit Objectives

At the end of this Unit the trainee will be able to:

1. Explain the process of water distribution in municipal, residential, and private setups
2. List the process and various components of a water supply and distribution system
3. State the piping system layouts for various types of water supply systems

4.1.1 Introduction to Water Distribution System

A water distribution system is a component of the water supply network that transports potable water from a centralized treatment facility or wells to users to meet their needs for household use, business use, industrial use, and firefighting.

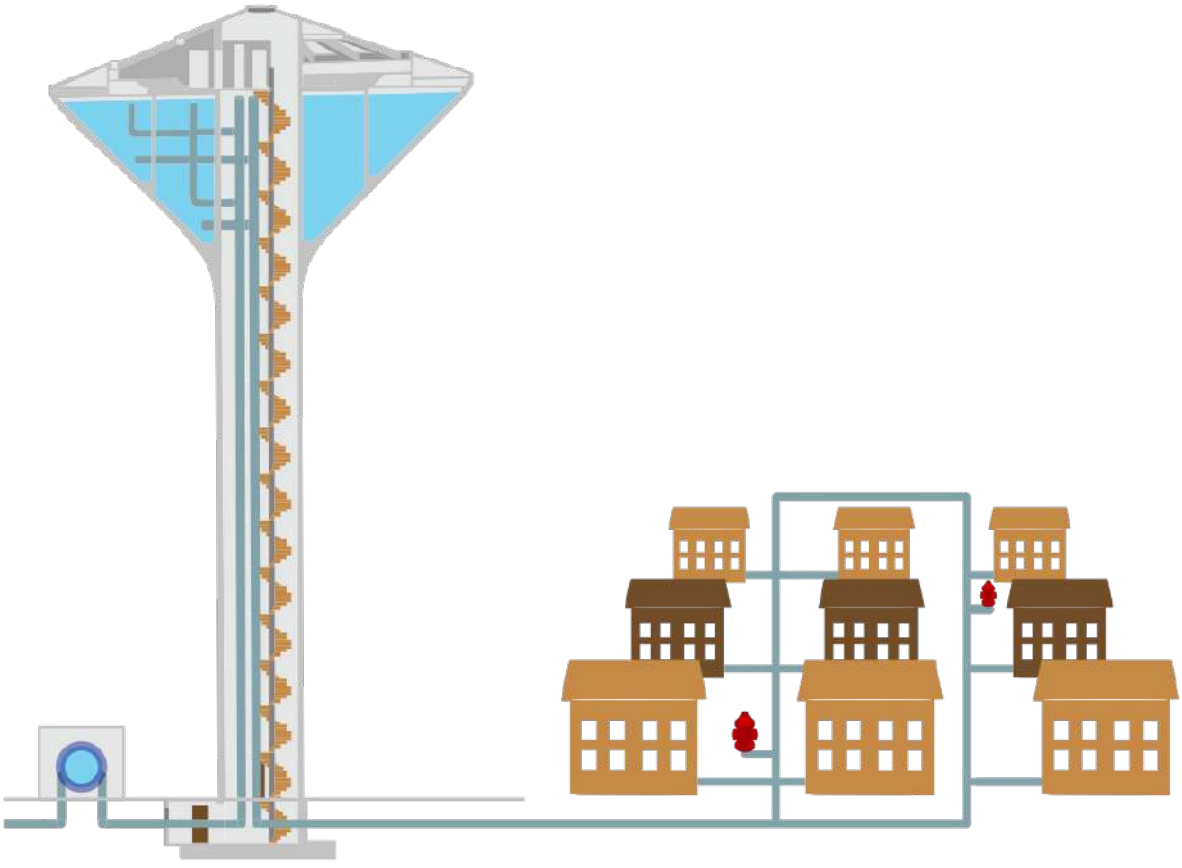

Fig 4.1 Water Distribution System
Source: Wikipedia

4.1.2 Water Distribution System in a Residential Building

Water is transported from the street mains to the specific building, where it is then delivered to the taps and other fixtures. Through the home service connection, the main line's supply is made available to the individual. Water is conveyed from the municipal tanks to the main water supply lines to the residential building, where the house owner or any person stores the water in the water tank or other storage material. Internal pipes in a building are used for water distribution. Residential structures are typically one, two, or three stories tall. A service pipe connects each residence to the public water main. The service main is joined by a water meter.

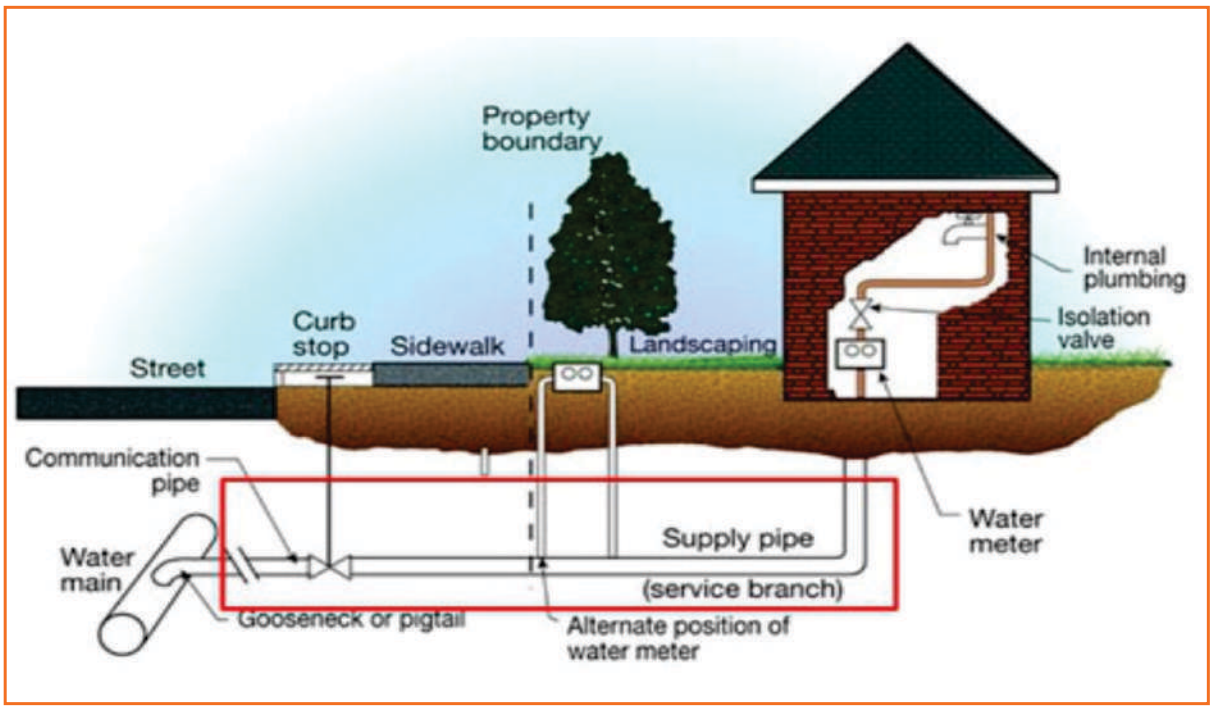

Fig 4.2 Residential Building Water Distribution System

Source: https://www.sedimentaryores.net/Pipe%20Scales/Service_lines.html

a) Water Distribution Systems in Residential Buildings

There are two types of water distribution systems used in residential buildings

Continuous System

In this system, water is available to the consumer for all 24 hours of the day. There is no doubt this system is best because the water is available whenever it is needed, but it also wastes the water.

Intermittent System

In this system, the user only receives water during a limited number of predetermined hours of the day, such as from two to four in the morning and two to four in the evening

Fig 4.3 Types of water distribution systems used in residential buildings

b) Service Pipes

These pipes are the pipes that connect the home's plumbing system to the municipal water supply distribution main.

For service pipes, the following materials are frequently used:

- **Lead pipes:** These pipes have highly resistant to corrosion. It also has a high hydraulic coefficient of flow and flexibility.
- **Copper pipe:** Copper pipe is non-corrosive with the most water. It is widely used in better-quality homes and areas where groundwater is extremely corrosive to steel pipes.
- **Galvanized iron pipe:** These are used where water is suitable. These are widely utilized in India since they are less expensive than copper tubes.
- **Polythene pipe:** Solely for cold water service pipes, these are being used more frequently on both inside and external surfaces. It is less expensive. Non-corrosive and heavy.

c) Services connection

A service connection primarily connects the consumer to the distribution network. A consumer could be a single residence, an apartment building, a master-planned neighborhood, or a water district purchasing water in bulk.

- **Brass or bronze:** A ferrule is placed into the main, typically under pressure, to provide a standard service connection to the home. This connection can be installed without having to turn off the main.
- **Gooseneck:** This consists of a flexible, curved length of pipe that is 40 to 50 cm long and is constructed of brass, copper, or lead. The gooseneck depicts the breaking of the service pipes due to movement between the service pipe and the water main.
- **Main service pipe:** It could be made of different materials depending on the system. Its diameter can range from 12 to 40 millimeters.
- **Water meter:** It is set up in a suitable chamber that has a cover. It calculates the amount of water the consumer uses.
- **Stop cock:** It is set up in a suitable chamber and covered to cut off the supply while the plumbing system is being repaired.

4.1.3 Municipal Water System

This water system is a public water supply system that includes a municipal water treatment facility, storage buildings such as water tanks, towers, and reservoirs, and piping infrastructure for distributing treated water to residential and commercial customers. Municipalities require reliable sources of clean water.

Municipal water supply systems comprise infrastructure for distribution, purification, transmission, and storage. The layout of these facilities is determined by the water's quality, the user's or consumer's specific requirements, and the volume of water that needs to be processed.

4.1.4 Fundamentals of Water Supply and Distribution System

The fundamentals of the Water Supply and Distribution System are listed below:

- In the distribution pipelines, the quality of the water should not degrade.
- The supply system should be able to deliver water with sufficient pressure heads to all intended sites.
- This system should be capable of supplying the needful amount of water during fire-fighting.
- According to the pipe arrangement, no consumer should be without water while any portion of the system is being repaired.
- Preferably, all of the distribution system's pipes should be installed one meter away from or above the sewer lines.
- To minimize losses caused by leakage, the pipe system should be reasonably water-tight.

4.1.5 Types of Water Distribution System

Following are the four major types of a water distribution systems:

- Dead-end or Tree Distribution System
- Gridiron Distribution System
- Circular or ring Distribution System
- Radial Distribution System

Fig 4.4 Types of Water Distribution System

1. **Dead-end or Tree Distribution System:** In this type of water distribution system, the main pipeline runs through the middle of the building, and the sub-mains branch off on both sides. The sub-main lines are then separated into various branch lines, from which service connections for specific houses are given.

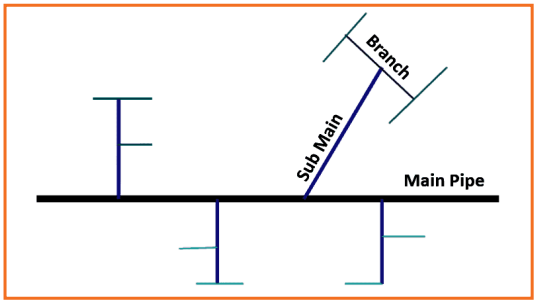

Fig. 4.5 Dead-end or Tree Distribution system

Source: https://civiconcepts.com/blog/types-of-water-distribution-system

2. Grid Iron Distributing System:

In this system, the building's main supply lines pass through its center, with sub-mains branching off in opposite directions. The branch links the sub-mains together. This system is unique in that all pipe types are connected and have no dead ends. Water can enter the system from any direction and reach the prescribed point of withdrawal, providing for more flexible operation, especially when repairs are required.

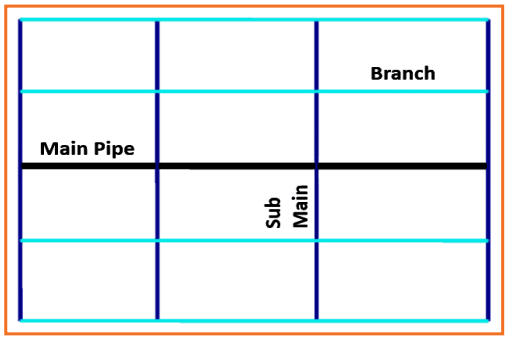

Fig. 4.6 Grid Iron- Water Distribution System
Source: https://civiconcepts.com/blog/types-of-water-distribution-system

3. Ring or Circular Distribution System:

The supply mains form a ring around the area in this type of water distribution system. Crosswise connections are made between the branch pipes, the main pipes, and one another. The most stable places for this system are planned locations with multiple buildings nearby.

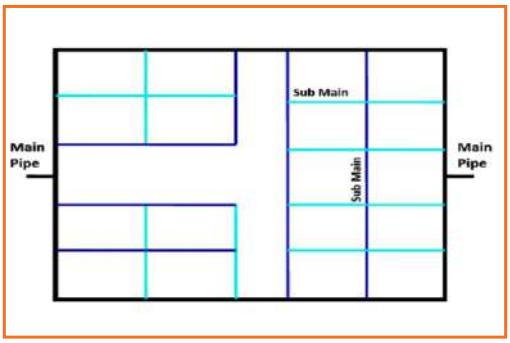

Fig. 4.7 Ring Water Distribution System
Source: https://civiconcepts.com/blog/types-of-water-distribution-system

4. Radial Distribution System: The entire structure is separated into various distribution sections in this form of the water distribution system. There is an elevated reservoir in the center of each building from which distribution pipes radiate outward to the distribution zones. This method provides prompt service with minimal head loss. The pipe laying method has a considerably more straightforward design.

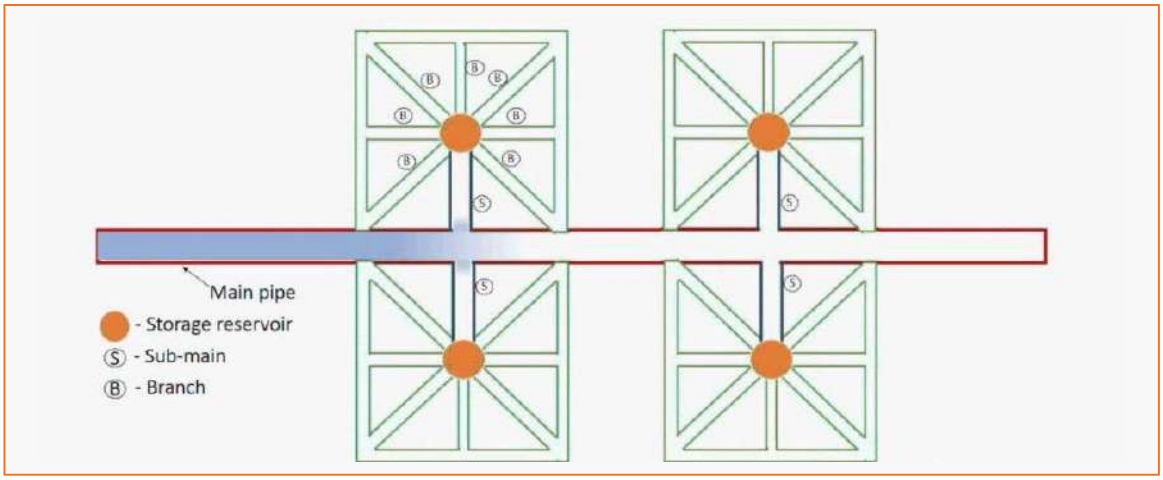

Fig 4.8 Radial Distribution System
Source: https://civiconcepts.com/blog/types-of-water-distribution-system

4.1.6 Various Components Water supply and Distribution System

Water distribution systems deliver drinking water to users' taps from a centralized treatment plant or well supply. These systems are made up of pipes, pumps, valves, reservoirs, tanks, water meters, fittings, and additional hydraulic accessories. Different components of water supply and distribution system are listed below:

Fig 4.9 Various components of water supply and distribution system

a) Pipes

Pipes are used to transporting water from one place to another place. Different types of pipes and their applications are explained in **Module 2-Unit 2.2.2 Types of Pipes.**

b) Pumps

A pump is a mechanical tool used to move liquids from a low-pressure or lower level to a high-pressure or higher level. It is a large piece of machinery with a weak suction and a strong discharge pressure. This makes it simpler to push fluid up to the desired height from a specific depth. There are many different kinds of pumps on the market, and they may be categorized according to their use, size, construction, and orientation, etc. The two categories of pumps are:

I. Rotodynamic pumps

II. Positive displacement pumps

I. Rotodynamic pumps

The water inside a casing is rotated by a wheel or other spinning component in a rotodynamic pump. An impeller is a revolving component that assists in giving water energy. The impeller's design should force the water outward at a right angle to its axis, or it should provide the water with both axial and radial velocities, or it should only force the water in one direction. Rotodynamic pumps can be further divided into centrifugal or axial-flow pumps depending on the type of force applied:

Centrifugal Pump: Centrifugal pumps move fluids by converting the kinetic energy of rotation into the hydrodynamic energy of the fluid flow. An engine or electric motor is normally where the rotational energy comes from. In industrial, agricultural, and home applications, centrifugal pumps are frequently used to pump water, solvents, organics, oils, acids, bases, and any "thin" liquids. In reality, there is a centrifugal pump design that may be used in almost any situation where low viscosity fluids are present.

Axial-Flow Pump: Axial-flow pumps are another name for axial-flow machines. The fluid is circulated in these pumps in a direction parallel to the shaft.

Fig 4.10 Centrifugal Pump

Source : https://www.gardnerdenver.com/en-hk/robuschi/centrifugal-pumps/centrifugal-pump-for-water

Fig 4.11 Axial Flow Pump
Source: Indiamart

II. Positive Displacement Pump:

This pump operates on the idea of creating a vacuum in a chamber mechanically. In accordance with this theory, the pump takes in water that is mechanically moved and then driven out of the chamber. Positive-displacement pumps come in two different varieties: Rotary pumps and Reciprocating pumps.

Rotary Pump: The rotary motion in this pump is produced by a pair of cams or gears that mesh together and rotate counterclockwise.

Reciprocating pump: By applying pressure, the reciprocating pumps assist in the transfer of a specific amount of liquid. One of the most often used reciprocating pumps is the hand pump, however, it is an antiquated design.

Fig 4.12 Rotary Pump
Source: Indiamart

Fig 4.13 Reciprocating Pump
Source: Indiamart

c) Valves

A valve that regulates, directs, or controls the flow of a fluid (gases, liquids, etc.) by opening, closing, or partially obstructing different passages. Following are the different types of valves used in the water distribution system:

I. Gate Valve

A gate valve also known as a sluice valve, opens by raising a barrier (gate) out of the flow of fluid's passage. In most cases, a gate valve is used to totally stop the fluid flow or, when fully opened, to allow full flow in a pipeline. As a result, it can be used either totally closed or fully open. A gate valve's components include the valve body, seat, and disc, as well as the spindle, gland, and wheel that controls the valve.

II. Pressure Relief Valve

This valve is also known as a pressure lowering valve and is used to lower water pressure in plumbing systems, frequently to a set level. This kind of pressure regulator may be required in homes that receive high-pressure water from a municipal source to protect the pipes and appliances.

Fig 4.14 Gate Valve
Source: Indiamart

Fig 4.15 Pressure Relief Valve
Source: Indiamart

III. Globe Valve

Globe valves are alternately called stop valves and contain a stem that controls a disc inside the mechanism. Although the valve body often has a bulging shape, many globe valves no longer feature a spherical design, despite the name “globe” remaining in common usage. They are easy to maintain, have effective throttling and shutoff abilities, and are frequently used in outdoor residential faucets as well as boiler and cooling water systems.

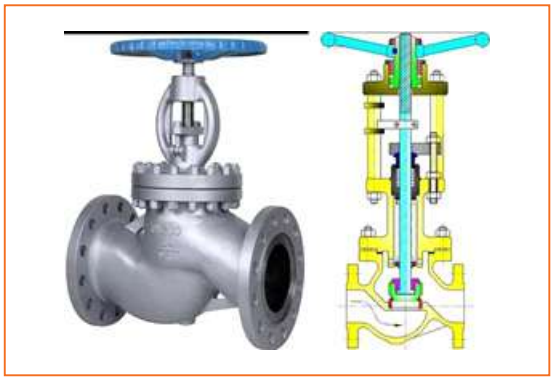

Fig 4.14 Gate Valve
Source: Indiamart

IV. Ball Valve

In new homes, ball valves are frequently found. They move a hollow, perforated sphere inside the device by turning a handle. The hole instantly opens or closes the water flow when the handle is turned.

V. Faucet Valve

In order to specifically manage the water flow from kitchen and bathroom faucets, faucet valves are employed. Water valves of various forms, such as ball valves, cartridges, ceramic disc valves, and compression valves, are available for this use.

Fig 4.16 Ball Valve
Source: Indiamart

Fig 4.17 Faucet Valve
Source: https://tameson.com/valves/ball-valve/manual/2-way/brass/faucet-and-boiler/g-3-8-inch-brass-2-way-faucet-ball-valve.html

VI. Supply Stop Valve

Shut-off valves, also known as supply stop valves, are made to stop the flow of a water supply.

Fig 4.18 Supply Stop Valve
Source: https://www.alibaba.com/product-detail/Valve-Made-In-China-Hot-selling_1600109599857.html

d) Reservoir

A large natural or man-made (artificial) lake is used as a water supply.

e) Water Tank

This is used to store the water from the water supply system, whenever water is required for use.

f) Water Meter

Water metering is the process of measuring water use. The purpose of a meter is to measure the quantity of water consumed by a building. There are different types of meters to measure different quantities of water.

Fig 4.19 Water Tank
Source: Indiamart

Fig 4.20 Water Meter
Source: Indiamart

g) Fittings

Fittings are fixed in the plumbing system to join straight pipes or any section of tubes. We can say that the water-supply fittings like elbow, tee, socket, reducer, etc., are fitted to change the direction of flow, distribute the water supply from the main pipe to other pipes of equal size or lower size, etc.

h) Additional hydraulic accessories

Following are the different hydraulic accessories used in plumbing:

- Hydraulic hoses and fittings.
- Pneumatic hoses and fittings Adapters, nipples, plugs.
- Ball valves.
- Clamps.
- Quick couplings, pressure gauges.
- Low-pressure fittings in cast iron, brass, galvanized, and stainless steel.

4.1.7 Piping System Layouts

The piping layout is the process of defining the equipment, the maintenance areas, and the necessary electrical requirements. The piping is then routed to complete the equipment's process function, and the space needed for operation is added. Various steps involved in piping system layout are listed below:

1. **Contoured Plan, Map Survey, and Preparation:** The land between the treatment plant (waterworks) and the distribution area is surveyed to obtain levels for determining the alignment of the main pipeline that will transport treated water to the distribution area. The distribution area (city or town) is also thoroughly surveyed, and a contoured map of the area is developed to locate the distribution zones, distribution or service reservoirs, pumping stations, and so on.
2. **Tentative Layout:** The entire distribution area (city or town) is divided into numerous distribution zones, which are marked on the distribution area's detailed map. The population density (i.e., the average number of people per hectare area) for each zone is also indicated. The layout scheme to be used has been determined, and the tentative alignment of all mains, sub-mains, and branches, as well as the positions of distribution or service reservoirs, valves, hydrants, and other appurtenances, has been marked.
3. **Discharge in Pipe Lines:** The discharge required by each pipeline is calculated based on population density, distribution zone type (i.e., residential, commercial, etc.), and fire demand. The distribution pipes are fixed in size so that minimal residual pressure is maintained at all points.
4. **Pipe Diameter Calculation:** For the known design discharge, pipe diameters are estimated to range from 0.6 to 3 m/s. For smaller diameter pipes, a lower velocity is assumed, whereas a higher velocity is assumed for bigger diameter pipes. The loss of head in the pipes is then computed using the Hazen-Williams formula, the Darcy-Weisbach formula, or Manning's formula. There are four variables:
   a) Discharge Q in m3/s or litres/s second;
   b) Diameter of pipe in mm,
   c) Loss of head in meters per 1000 m length of pipe, and
   d) Velocity of flow in m/s.
5. **Computation of Available Residual Pressure Heads:** Starting with a distribution or service reservoir or a pumping station where the total pressure head is known, the pressure head available at the end of any pipeline can be calculated by allowing for frictional head loss and any rise or fall due to pipeline slope and ground levels. The anticipated pipe size should be updated if the available residual pressure head is less than the required minimum residual pressure head.

Notes

UNIT 4.2 - Installation Process

Unit Objectives

At the end of this Unit the trainee will be able to:

1. Outline the installation process of pipes and fittings for various plumbing applications
2. Describe the various techniques of installing the water piping system in a building such as over ground piping, underground piping, piping embedded in concrete, concealed piping, wall mounted piping.
3. Explain the properties of the different types of supports, hangers and restraints used in water supply plumbing systems
4. List the characteristics of metal used in various plumbing materials and the fabrication methods compatible with them
5. Explain the process of electrolysis and problems associated with the use of dissimilar metals
6. State the impact of accurate marking on the fabrication process work time and finished work quality
7. Describe the measuring and marking out processes for fabrication of pipe
8. List standard measuring procedures such as center-to-center, end-to-center, and end-to-end
9. State the allowances to be considered in measurements and markings during the fabrication of pipes
10. List the types, characteristics and the application of different pipe fittings and fixture supports
11. Discuss the various fixing and jointing techniques for water supply piping installations
12. Explain the principles underlying various fit-off processes
13. State the importance of ensuring alignment and balance in piping installations

4.2.1 Installation Process of Pipes and Fittings

A plumber should be aware of the following points while installing pipes and fittings:

1. Familiar with all plumbing codes.
2. Prepare the site for plumbing works.
3. Proper installation of drain and vent lines.
4. Proper installation of copper supply lines.
5. Installation of sanitary fittings (like tub, shower, or sink).
6. Installing a wet wall or tiles.

1. **Familiar with all plumbing codes:** The person should well know about all plumbing codes used during plumbing work. These codes ensure that your new building plumbing is installed safely. While certain codes differ from state to state, others are essentially common.
2. **Prepare the site for plumbing works:** First frame the space for plumbing works where the fittings and fixtures are installed. Before installation check the power line. Make sure you have a tape measure for careful measuring.

3. **Proper installation of drain and vent lines:** Mark and select the right place for drain and vent lines and make sure to install them before the supply lines. If you don't get to the right place, you should re-do your work completely to install the fixtures.

   When you begin installing the drain pipes, they may not lay exactly as you expected. You can begin constructing the components and then fit them together. Your plans might be changed as you go. You may wish to slant the vent pipes when installing the vents. Some inspectors may insist on this, but not all.

4. **Proper installation of copper supply lines:** The ease with which copper tubing may be placed gives it a significant advantage over brass or galvanized iron tubing. Tubing is available in 100-foot-long rolls. The tubing is sturdy enough to endure handling, but it is also supple enough to bend around obstacles, saving time and money on numerous fittings.

5. **Installation of sanitary fittings (like tub, shower, or sink):** If you're installing a tub or shower faucet, use 3/4-inch supply pipes to ensure adequate water pressure. Tap into the cold/hot water pipes as close to the water heater as possible to ensure that the water is as warm as feasible.

   If you haven't previously, you should install shutdown valves in the lines. When installing the faucet, make sure you follow the manufacturer's instructions. Each faucet is somewhat unique. A bathroom sink vanity is less difficult to install than a porcelain sink that stands alone.

6. **Installing a wet wall or tiles:** After you've installed the tub or shower and the piping, it's time to add a wet wall or tile to the shower/tub wall.

   Before installing your wet wall, make sure to wipe all surfaces. If you're putting it over plaster, make sure to seal it before putting up the wet wall. Leave a few millimeters between the tub and the panel when installing your wet wall. The gap can be filled with grout or a sealant.

4.2.2 Various Techniques of Installing the Water Piping

Following are the various techniques for installing the water piping system:

- Over Ground Piping
- Underground Piping
- Piping Embedded in Concrete
- Concealed Piping

Fig 4.21 Various techniques for installing the water piping system

1. **Over-ground piping:** This is also known as above-ground water systems. In this pipe is laying above the ground surface.
2. **Under-ground piping:** In this pipeline laying under the ground surface. Buried or underground piping is piping that comes into contact with dirt or runs below grade level. Buried pipework is commonly used in the oil and gas industries. All underground pipes are buried with a minimum depth of cover of 500-1000 mm on top of the pipe.

Fig 4.22 Overground Piping
Source: Wikipedia

Fig 4.23 Underground Piping
Source: https://www.tuv.com/india/en/sewers-and-underground-piping.html

Underground Piping Materials

Different underground piping materials that are widely popular in the buried piping industry are:

Material	Uses in Underground Piping
Carbon Steel	closed-drain systems, cooling water, and firewater
Stainless steel	closed drains—chemical and corrosive service
Concrete pipe	surface drainage, and for 15" and larger pipes
Glass Pipe	floor drains in process plants, mainly acid service
Fiberglass reinforced plastic pipe	corrosive service, low-temperature and -pressure systems
PVC	corrosive service
Cast iron	stormwater and oily water drains (hub and spigot fittings)
Vitrified clay pipe	gravity drain systems
Ductile iron	Process water

Table 4.1 Underground Piping Materials

3. Piping embedded in concrete

Embedments are many things, such as pipes, ducts, sleeves, and conduits, that are embedded in concrete elements for various purposes. Embedments are widely made from a variety of materials. They are typically used for services like ventilation and cable passing.

Fig 4.24 Pipe Embedded in Concrete
Source: https://theconstructor.org/concrete/embedments-reinforced-concrete/21700/

4. Concealed Piping

To gain access to piping, it is frequently necessary to remove permanent construction. Concealing pipes in the wall provide them with some security. This implies they will not be damaged until there is a significant impact on the wall itself. Exposed pipework, on the other hand, can be bumped and release a leak if it is hit hard enough to cause damage.

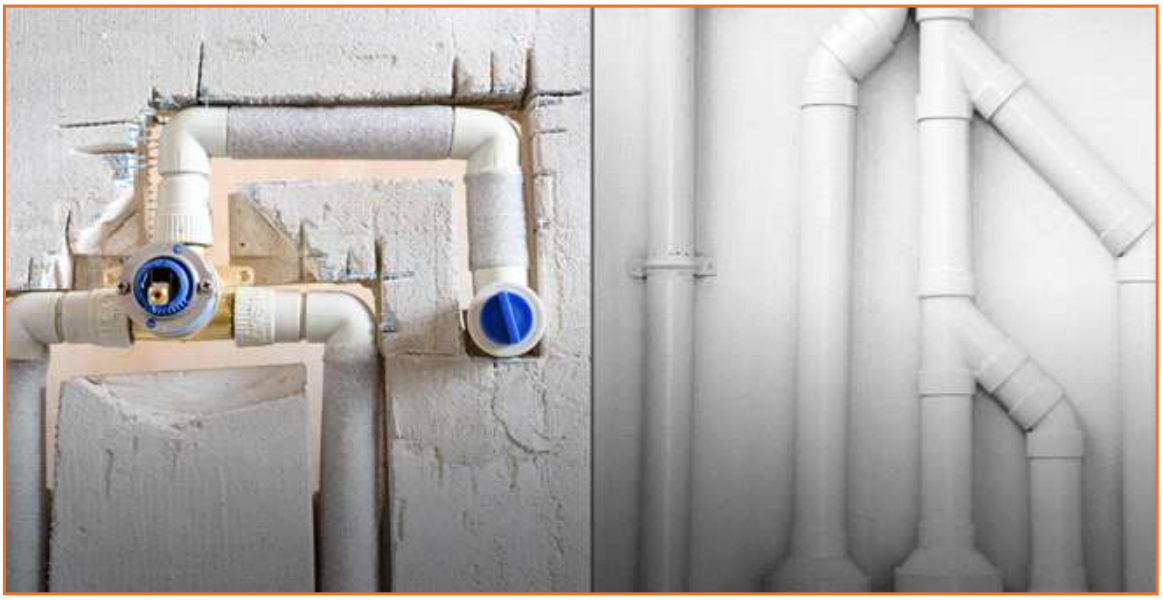

Fig 4.25 Concealed Piping
Source: https://www.zameen.com/blog/concealed-exposed-plumbing-home.html

4.2.3 Different Types of Supports, Hangers, and Restraints

1. **Pipe Support**

   Pipe support is designed to carry the pipe weight while simultaneously permitting deflection in vertical and/or horizontal directions. Support providing stiffness in at least one direction. Primary and secondary support are the two main types of pipe support structures. Primary supports connect the pipeline directly. On other hand, secondary pipe supports are attached to the structure that supports the pipe.

2. **Pipe Hanger**

   A support by which piping is suspended from a structure that functions by carrying the piping load in tension. Pipe hangers and supports are devices that transfer loads from the pipe or structural attachment to the supporting structure or equipment. The following are the types of hangers used in pipe work: Rod hangers, spring hangers, clevis hangers, brackets, clamps, clips, or loops used to suspend pipes (as from ceilings, and overhead beams).

3. **Pipe Restraint**

   A pipe restraint is intended to control movement while also extending the life of your process system. Unchecked movement in piping systems creates friction, which wears out pipes, increases vibrations, and leads to breakage. It can result in ruptured pipes or more extensive damage to the entire system. Piping restraints play an essential role in ensuring safe water and wastewater system operations. To identify the most appropriate constraint to utilize, consider parameters such as local soil conditions, materials, existing infrastructure, deflection, seismic activity, and cost.

4.2.4 Metal Used in Various Plumbing Materials

In plumbing work, it is very important that the quality of the material should be as per recommended criteria. The metal used in various plumbing works must have the following characteristics such as strength, hardness, malleability, ductility, thermal expansion, and good conductivity.

Pipe fabrication is the process of welding piping components such as pipes, elbows, tees, and flanges into engineered piping systems that meet our clients' design specifications. Following are the two different types of pipe fabrication:

I. Shop Pipe Fabrication

II. Field Pipe Fabrication

There are several elements that influence whether pipes are shop-produced, field fabricated, or both. In most cases, both shop and field pipe fabrication is employed. Profitability, project type and size, piping material and size, post-fabrication surface treatment, environmental condition, accessibility of equipment, experienced staff availability, time requirement and availability, and so on are the primary decision criteria.

4.2.5 Electrolysis Process

It is the process by which ionic substances are decomposed into simpler substances when a current is passed through them. Electrolysis is the process of passing an electric current through a substance to cause a chemical change. A chemical change occurs when a material loses or acquires an electron (oxidation or reduction). The procedure is carried out in an electrolytic cell, which is a device comprised of positive and negative electrodes held apart and immersed in a solution containing positively and negatively charged ions. The substance to be converted might be the electrode, the solution, or it could be dissolved in the solution. Electric current (i.e., electrons) enters the system through the negatively charged electrode (cathode); solution components move to this electrode, mix with the electrons, and are converted (reduced). The end result could be neutral elements or new compounds.

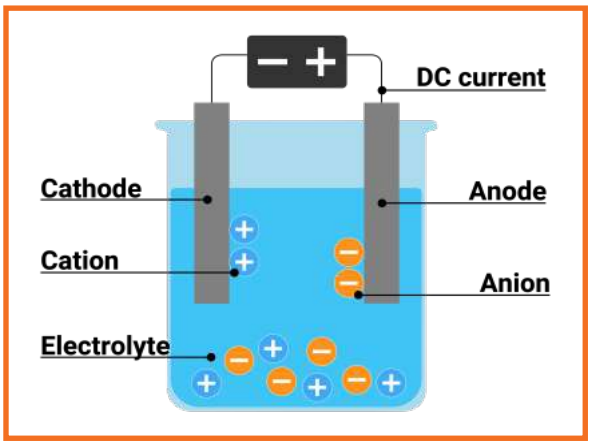

Fig 4.26 Electrolysis

Source: https://byjus.com/jee/electrolysis/

Corrosion can also occur when different metals are not physically in contact but are electrically coupled by stray electrical currents conveyed through a conductive medium, such as tainted water. This process is known as electrolysis when a conductive solution is involved.

4.2.6 Impact of Accurate Marking on the Fabrication Process

During pipe fabrication work marking is a very important step to perform the correct process. The process of transferring a design or pattern to a workpiece as the first step in the manufacturing process is referred to as marking out or layout. Accurate labelling and measurement are essential for ensuring components fit together properly.

Fig 4.27 Pipe Fabrication

Source: https://www.pipingengineer.org/pipeline-fabrication/

4.2.7 Measuring and Marking out Processes

Measuring is the process to measure any object with dimension (length, width, and height). The process of measuring and marking lines on the surface of materials that will be utilized for manufacturing is referred to as marking out.

Measuring and marking tools help ensure precise measurements and even placement throughout your next home improvement job. View more images of hand tools. Almost every home improvement job necessitates precise measurements. That is why having a collection of measuring and marking instruments is essential.

Name	Measuring Instrument	Description
Vernier caliper		Vernier caliper is used to measure the thickness between two surfaces of an object
Micrometer		Micrometer is used to measure linear measurements such as diameter, length and thickness of solid bodies
Inside and Outside Caliper		It is used to determine the shorter lengths between two sides of an item
Feeler Gauge		Feeler gauge is also called thickness gauge. It consists a number of blades of thin flexible steel strips, which are ground to a thickness ranging from 0.03 to 1mm. The purpose of this gauge is to check clearance between two surfaces
Pressure Gauge		It is used to measure the pressure of fluid
Steel ruler		It is used to measure short lengths and making dimensions on the workpiece
Measuring tape		It is used to measure lengthy dimensions and curves or corners of the components

Table 4.2 Measuring Instruments

4.2.8 Standard Measuring Procedures

Following are the standard measuring procedures used in plumbing:

- Center to Center
- End to Center
- End to End

Fig 4.28 Standard Measuring Procedures

I. **Center-to-Center:** To determine the center-to-center measurement, remove your present pulls with a screwdriver, then take a ruler or measuring tape and measure from the center of one screw hole to the center of the other screw hole. Simply lay your tape measure or ruler in the center of one hole and measure to the center of the other. The end of a ruler can wear away and the edge of a tape measure can bend. Place the 1-inch mark in the center of the first hole for the most accurate measurement.

II. **End-to-Center:** Taking an End-to-Centre Measurement Correct technique involves hooking the tape measure over the end of a pipe, aligning the tape to be parallel with the pipe, and measuring to the nearest ⅛". Fitting allowance is an important concept for young people investigating trades to understand. An end-to-center measurement is used when there is a fitting on only one end of a pipe. The end-to-center measurement is the distance from the point on a fitting where the two center lines meet to the end of a pipe. A center-to-center measurement is used when both ends of a pipe have a fitting.

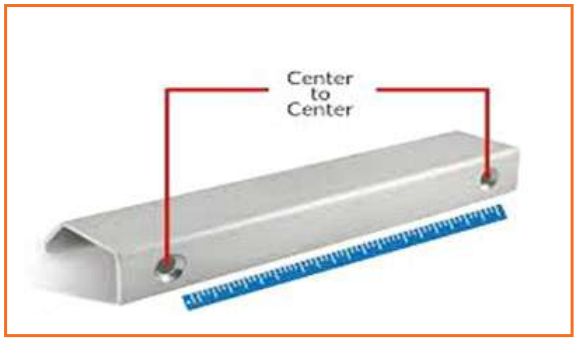

Fig. 4.29 Center to Center

Source : https://www.mockett.com/blog/blog-2018-cabinet-hardware-center-to-center.html

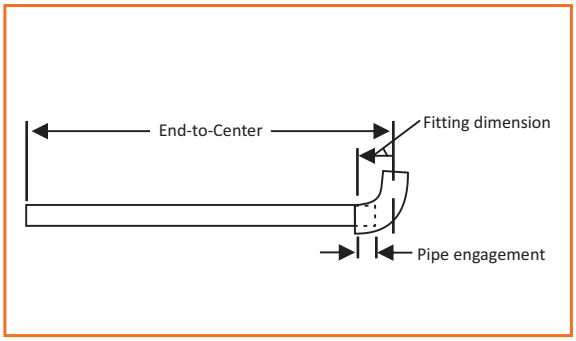

Fig. 4.30 End to Center

Source: https://waybuilder.net/sweethaven/BldgConst/Plumbing01/lessonmain.asp?iNum=fra0202

III. **End-to-end:** Correct technique involves hooking the tape measure over the end of a pipe, aligning the tape to be parallel with the pipe, and measuring to the nearest ⅛". Fitting allowance is an important concept for young people investigating trades to understand.

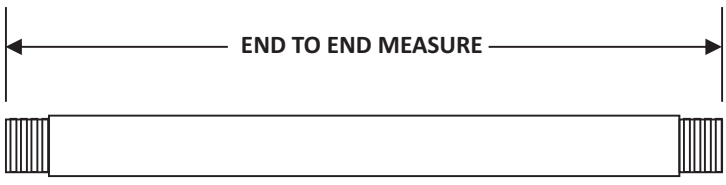

Fig. 4.31 End to End

Source: https://armyordnance.tpub.com/Od16218/Od162180169.htm

4.2.9 Measurement Allowance

The right amount of allowances is given for pipe fabrication works because it is a very difficult task to perform. During fabrication work, workers should be very attainable of the task and follow all safety precautions.

4.2.10 Different Types of Pipe Fittings

Different types of pipe fittings used in plumbing system are explained in **Module 2: Unit 2.2.3 Pipe Fittings.**

4.2.11 Different Types of Pipe Joints

Different types of pipe joints used in plumbing system are explained in **Module 2: Unit 2.2.4 Pipe Joints.**

4.2.12 Importance of Alignment and Balance

Piping difficulties have a direct impact on the life and operation of a pump. It is difficult to bring the pump to the pipe in one action and expect a good pump flange or vessel fit. When bringing the pipe to the pump, always leave the last spool (suction and discharge sides, respectively) until the pump has been leveled and roughly aligned. The ultimate alignment will be a free bolt condition with no come-along, which may surprise some readers. Pumps will endure longer with fewer failures of seals, shafts, bearings, and couplings if an early, common-sense investment and proper attention to details are made. More equipment uptime and less production downtime will result in significant cost savings and fewer.

Misalignment Issues:

I. **Heavy Equipment Settling** – Operators must check the soil conditions that cause equipment to shift or sink over time.

II. **Construction "Tolerance"** - It is extremely difficult to achieve exact alignment in construction with greater diameter piping.

III. **Piping Damage** - Any damage that happens over time and causes even minor distortion of the piping can generate possible alignment concerns.

The problem with piping misalignment is that it exerts strain on flange connections, causing maintenance problems with expensive equipment. Properly recognizing the problem is difficult to resolve piping alignment difficulties. Both the types of misalignments and the predicted change over time should be included. For example, settling is likely to worsen over time, thus a fixed solution will be less successful than one that allows for change.

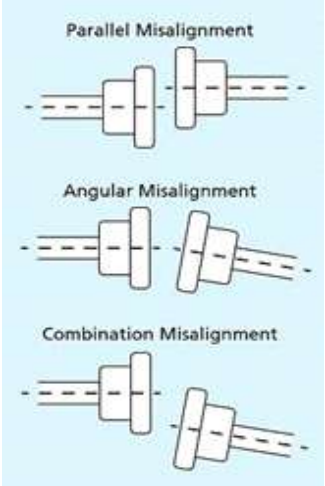

Fig 4.32 Pipe Misalignment

Source : https://www.techtransfer.com/blog/shaft-alignment/

UNIT 4.3 - Testing Procedures

Unit Objectives

At the end of this Unit the trainee will be able to:

1. Describe the test procedures to check proper functioning of the pipework installed
2. Describe the checks and procedures to be conducted before commissioning
3. Explain the importance of reporting any difficulties as soon as they arise

4.3.1 Testing of Pipeline

Following are the types of tests to be conducted to check the proper functioning of the pipeline.

I. Ultrasonic Tests (UT)

Ultrasonic testing is the process of delivering a high-frequency sound wave into one exterior side of a material and reflecting the sound wave from its interior surface to provide an accurate measurement of wall thickness. Corrosion and other forms of degradation can cause walls to shrink and lose strength over time.

II. Hydrostatic Tests

A hydrostatic test is a pressure test that is used to examine the integrity of a pipe or other component. This test is used to assess the structural integrity of pipelines and other pressure-carrying infrastructure. Hydrostatic testing is isolating the pipeline section being tested, filling it with water, and then pressurizing the line to a predetermined pressure to check for leaks.

Fig 4.33 Ultrasonic Pipeline Testing
Source: Wikipedia

Fig 4.34 Hydrostatic Test
Source: Wikipedia

III. Magnetic Flux Tests

Magnetic flux leakage (MFL) is a non-destructive magnetic testing method used to identify corrosion, pitting, and wall loss in steel buildings. Magnetic flux leakage (MFL) is a technique extensively used in the petrochemical sector to inspect tank floors.

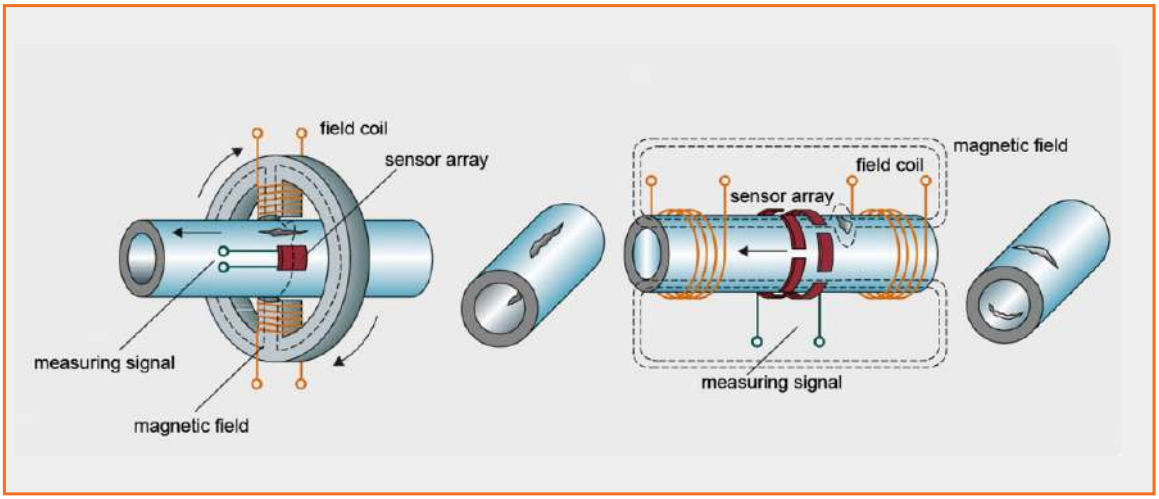

Fig 4.35 Magnetic Flux Test

Source: https://www.foerstergroup.com/en/usa/technology/flux-leakage-testing/

4.3.2 Pipe Inspection, Testing & Marking

During the manufacturing process, pipe inspection is a continual procedure. A pipe is subjected to many forms of inspection and testing to assure its quality. Refer to the list below for the many types of pipe inspections Metallurgical, Destructive, Hydro Test, NDT, Visual, Dimension, and Marking.

1. **Metallurgical Tests:** Metallurgical tests demonstrate that the pipe's chemical requirements meet the material standard. It is generally known as micro and macro pipe inspection & testing. In micro-analysis (Chemical Analysis) the following parameter should be checked or tested.

    - Raw material
    - Product
    - Weld ensures that all the alloying elements are within the range specified in the material standard
    - In macro analysis check the proper fusion of weld material with pipe material

    When the material is going to be used in hostile conditions, it is subjected to several particular pipe inspection tests. These testing will guarantee that the pipe material can likewise endure such harsh situations. Some of the tests are as follows:

    - Grain size (AS & SS)
    - IGC- Intergranular Corrosion Test (SS)
    - Ferrite (SS)
    - HIC- Hydrogen-induced Cracking
    - SSC- Sulfide Stress Corrosion Cracking

2. Destructive Tests:

- The tensile test is used to determine the yield and ultimate tensile strength of the pipe. Standard high and low-temperature tensile testing is also done if desired by the purchaser.
- Bend test / Guided bend test is performed to assess the weld joint's integrity.
- The flattening test evaluates a pipe's capacity to deform plastically.
- Impact test / Charpy V-Notch Test, used to determine a material's capacity to endure low-temperature circumstances.
- A creep test is performed to evaluate the long-term impact of temperature under a steady load.

Fig 4.36 Destructive Test
Source: https://specialpipingmaterials.com/destructive-testing/

Notes

4.3.3 Pipeline Pre-Commissioning Procedures Checklist

The process of demonstrating a pipeline's and piping system's ability to contain substance without leaking is known as pipeline pre-commissioning. This substance could be water, steam, CO2, N2, gasoline, aviation fuel, or multiphase hydrocarbons. Following are the steps involved in pre-commissioning:

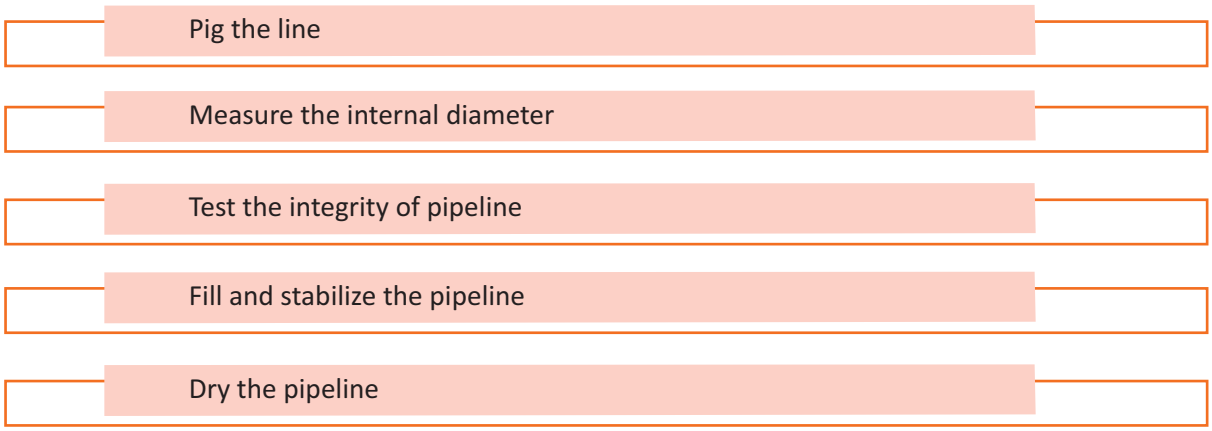

Fig 4.37 Pre-Commissioning Procedures

I. **Pig the line:** The first step in pre-commissioning operations is to wipe out the pipeline. This is usually accomplished by pigging the pipeline. To ensure that all construction debris is eliminated, a pipeline must be pigged before proceeding. This improves the accuracy of any tests conducted in the pipeline.

II. **Measure the internal diameter with a caliper:** The interior diameter of the pipeline is measured after it has been cleared of any debris or buildup. A caliper pig tool is a one-of-a-kind pig with mechanical sensors or limbs on its body. When these artificial fingers or arms are run through the pipe, they help record the interior structure of the pipeline. When this is finished, the pipe is ready for testing.

III. **Integrity test of pipeline:** Pipeline integrity testing is a proactive measure used to discover leaks and pipeline irregularities before they worsen. By testing your pipeline before launching it, you may address any potential concerns without risking downtime.

IV. **Fill and stabilize the pipeline:** A "fill pig" is a specialized instrument used to fill a pipeline. The fill pig is propelled through the pipeline by a column of test water. The pig eliminates any air in the pipeline as it travels through it. This air must be removed because it can lead to a failed pipeline integrity test later on. After the pipeline has been full, the next stage is to stabilize it. A pipeline is first mildly compressed (about 200psi) and then left for a predetermined period of hours. When the temperature and pressure of a pipeline have equalized, it is considered stable and ready for testing.

v **Dry the pipeline:** If you undertake a hydrostatic test, the final steps in the pre-commissioning procedure include dewatering and drying your pipeline after you've done your pipeline testing. The same pig that was used to fill the pipeline before hydrostatic testing is returned through it. This time, though, the pig is propelled back to the launch site by compressed air. The drying process can begin once the dewatering procedure is complete. The pipeline is then filled with more cleaning pigs and soft foam swabs. This is repeated until all standing water in the pipeline has been eliminated. Finally, using oil-free compressors and desiccant dryers, the pipeline is dried to the desired dew point. A -40° dew point is typically specified for pipeline drying.

4.3.4 Importance of Reporting

Reporting is vital for tracking performance over time. It enables you to make better decisions, forecast future outcomes, and drive continuous improvement. Every worker must know about safety precautions.

A successful occupational health and safety program includes the reporting of incidents. It helps in the identification of workplace health and safety hazards, risks, and dangers. The goal is to determine the reasons for occurrences. Appropriate controls can then be implemented to prevent similar incidents in the future.

An employee who understands why he or she is performing a certain activity is more likely to be not only more driven to finish the assignment but also more useful to the organization.

Reporting injuries as soon as possible allows the organization to provide choices for medical treatment in a timely way. Failure to follow the reporting process may result in someone missing out on early treatment and may be a violation of business policies and regulations. Information about accidents, incidents, and illnesses can be utilized to enhance risk assessment, assisting in the development of solutions to prospective problems. Records also aid in the prevention of injuries and illness, as well as the control of expenses associated with unintentional loss.

Notes

Summary

- A water distribution system is a component of the water supply network that transports potable water from a centralized treatment facility or wells to users to meet their needs for household use, business use, industrial use, and firefighting.
- Water is transported from the street mains to the specific building, where it is then delivered to the taps and other fixtures.
- Copper pipe is non-corrosive with the most water. It is widely used in better-quality homes and areas where groundwater is extremely corrosive to steel pipes
- A service connection primarily connects the consumer to the distribution network.
- Municipal water system is a public water supply system that includes a municipal water treatment facility, storage buildings such as water tanks, towers, and reservoirs, and piping infrastructure for distributing treated water to residential and commercial customers.
- In Dead-end or Tree Distribution System, the main pipeline runs through the middle of the building, and the sub-mains branch off on both sides.
- Water distribution systems deliver drinking water to users' taps from a centralized treatment plant or well supply.
- A pump is a mechanical tool used to move liquids from a low-pressure or lower level to a high-pressure or higher level.
- Centrifugal pumps move fluids by converting the kinetic energy of rotation into the hydrodynamic energy of the fluid flow.
- A valve that regulates, directs, or controls the flow of a fluid (gases, liquids, etc.) by opening, closing, or partially obstructing different passages.
- The piping layout is the process of defining the equipment, the maintenance areas, and the necessary electrical requirements.
- Electrolysis is the process by which ionic substances are decomposed into simpler substances when a current is passed through them.
- Ultrasonic testing is the process of delivering a high-frequency sound wave into one exterior side of a material and reflecting the sound wave from its interior surface to provide an accurate measurement of wall thickness.
- During the manufacturing process, pipe inspection is a continual procedure. A pipe is subjected to many forms of inspection and testing to assure its quality.

Notes

Exercise

1. Explain the process of the water distribution system a house or any building?

2. List the various components of the water distribution system

3. Write the installation process of pipe and fittings in plumbing.

4. Describe the measuring and marking out processes for the fabrication of pipe.

5. Describe the checks and procedures to be conducted before commissioning.

Notes

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WATER MANAGEMENT AND PLUMBING SKILL COUNCIL

5. Installation of the Drainage Systems

Unit 5.1 - Drainage System

PSC/N0132

Key Learning Outcomes

At the end of this module, the trainee will be able to:

1. Demonstrate the cutting, bending and assembling of various types of drainage pipes
2. Perform installation of drainage systems
3. Perform the various post-installation activities

UNIT 5.1 - Drainage System

Unit Objectives

At the end of this Unit the trainee will be able to:

1. Discuss the process of wastewater drainage — from a fixture to the drain and then to the environment — across various residential and commercial setups
2. Describe the functions of the components of drainage systems
3. Describe the various types of drainage piping systems and the pipes and fittings used in them
4. Discuss the type of drainage piping systems and its components used in various types of building
5. Explain the characteristics and the application of different pipe fittings, fixture supports and fastening hardware
6. Discuss the fit off, fixing and jointing techniques applicable for drainage pipes
7. Explain the allowances to be made for spring-back, distortion and assembly during marking for fabrication of pipes
8. Explain the procedure of installing various types of drainage systems such as sewage, sullage, stormwater, sub-soil drainage system, drainage for fixtures, etc
9. Identify the trap to be installed as per the type of drainage system
10. List different types of pumps used in sanitary and drainage systems and their applications
11. Discuss the characteristics of the flooring using for installation and levelling of drainage system
12. Explain the importance of conducting post-installation and pre-commissioning tests and checks
13. Describe the various post installation and pre-commissioning tests and checks
14. List the signages to be put up at the site after the plumbing task has been completed

5.1.1 Introduction to Drainage System

The drainage system is a well-organized network of drainage pipes that is utilized to dispose of human waste. Copper, CPVC, and HDPE pipes are commonly utilized in drainage systems. Because they are composed of plastic, they are rust-free and lightweight. They require little upkeep and are simple to install. These pipes are inexpensive and practical.

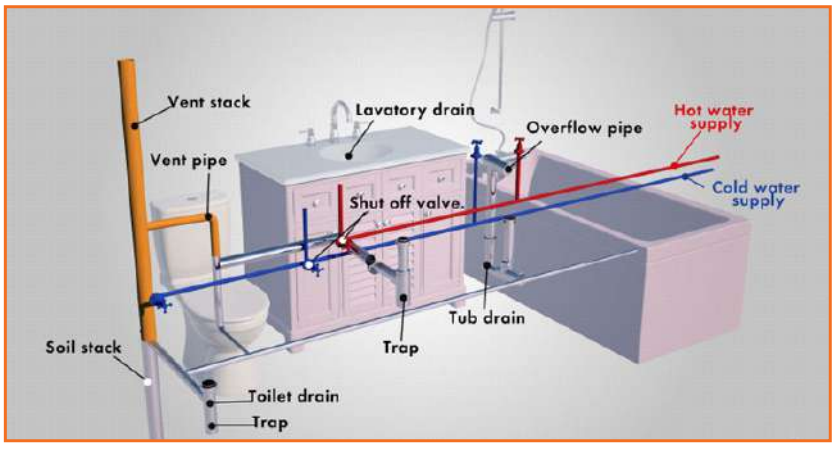

Fig 5.1 Drainage System in Building
Source: https://home.howstuffworks.com/home-improvement/plumbing/plumbing-basics-ga.htm

An efficient drainage system aims to keep excess water from damming up on the ground or underground. Without a good drainage system, excess water, particularly rainwater, can quickly accumulate.

Building drainage encompasses all necessary drainage methods used to protect buildings from harm caused by humidity or moisture from the surrounding soil. Importance. Building drainage is extremely important economically! Proper drainage can avoid 90% of all structural damage to basement spaces.

Gravity is used by the home's drainage system to draw water through the house and outdoors to drain. Waste and unclean water are routed through a "Soil Stack," which then transports the waste to a major drain, which is usually placed beneath the house.

Pressure is not a factor in drainage systems, as it is in supply systems. Instead, waste leaves your home since the drainage pipes all dip downhill towards the sewer. Gravity drags the waste forward. This downward flow is continued by the sewer line to a sewage treatment plant or a septic tank.

This is the most significant use of a proper drainage system; it allows water to flow freely and, in most circumstances, prevents accumulation that might lead to flooding. Drainage systems help prevent stagnant water from accumulating, which can enhance mosquito breeding.

5.1.2 Different Types of Drainage Systems

Different types of drainage systems used in a building are listed below:

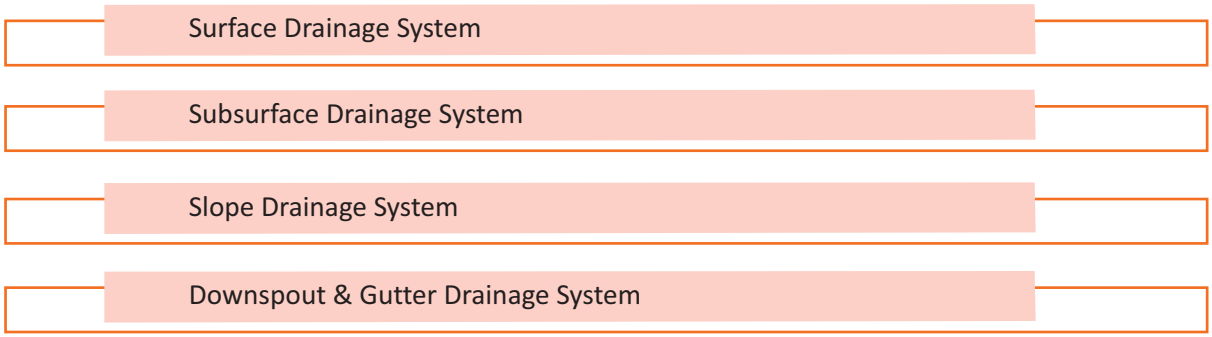

Fig 5.2 Types of Drainage Systems

1. Surface Drainage System

This technique eliminates excess water from the land's surface. This is necessary for the drainage of excess water from the ground's surface, which is accomplished through the use of enhanced natural channels or artificial drains. A surface drainage system boosts production on land where a high water table or moist soil conditions prohibit water from moving from the root zone. Surface systems are further subdivided into Regular Surface systems and Controlled Surface systems, with more information provided below:

- When there is excessive rainfall or irrigation that is run totally by gravity, a regular surface drainage system begins to function.
- A controlled surface drainage system is made up of check gates positioned around flat basins, such as those found in flatlands.

2. Subsurface Drainage System

This method serves to lower the water table and remove excess water through open ditches. During wet periods, the water table drops to keep the root zone unsaturated. This system is further divided into two types: relief drains and interceptor drains. Relief drains are used to lower the water table in order to serve vegetation and improve surface water.

Fig 5.3 Surface Drainage System

Source : https://abtdrains.com/the-different-types-of-surface-drainage-systems/

Fig 5.4 Subsurface Drainage System

Source : https://cementconcrete.org/transportation/subsurface-drainage-system/2934/

3. Slope Drainage System

It is designed in such a way that water can flow downward through it. This is accomplished by using high-quality pipes in a downward orientation. The downward movement of the pipe allows the water to flow quickly without being clogged. The optimum slope system solution is to slope the finish grade away from the home or building so that surface water can drain. A minimum slope of 1% is required for water to run down. The floor must slope to the drain with a tolerance of 1% - 2%. Polymer concrete underlayment will be a cost-effective option on a good slope system.

Fig 5.5 Slope Drainage System

Source : https://www.can.ltd.uk/technical-information/slope-drainage

4. Downspout & Gutter Drainage System

The Gutter downspout is a vertical pipe that is attached and helps the water travel out of the gutters away from the building, ensuring that all waste is safely separated through the system. The downspout also redirects water and safely sends it away from the building toward the specified drainage location. They will protect the building's foundation from water damage if they are clean of obstructions and properly installed. When it rains, downspouts are frequently directed onto surfaces such as driveways, directing water directly into the streets. Downspouts are also attached to a pipe that links either directly to the sanitary sewer or storms into the drain system. A downspout is required every 30-40 feet on average in a gutter.

Fig 5.6 Gutter Downspout Drainage System
Source: https://www.shutterstock.com/search/gutter-pipe

The gutter system consists of two parts:

- Gutter channels that run horizontally along the roof edge
- A downspout that transports the gathered water to grade level

Notes

5.1.3 Benefits of Drainage System

A drainage system keeps water from accumulating and causing flooding. It helps to move water away from the building and prevents water collection, which might stimulate mosquito breeding. A good building system aids in the removal of access water in any location affected by floodwater or rains. Its objective is to effectively remove wastewater; this system is known as a sewer system. The benefit of a drainage system is visible when stored water is drained out along with garbage in a systematic order and a strong network that aids in the removal of undesired clogs, resulting in the maintenance of a healthy state in a structure. Provides a better environment for plant growth. The benefits of a drainage system are listed below:

- Facilitates microbial breakdown
- Improves the soil's physical properties
- Keeps the soil temperature stable
- Promotes a stronger root system
- Helps in the clearance of harmful chemicals
- Aids in the prevention of water-borne illnesses
- Extends the life of the structure

Fig 5.7 Benefits of drainage system

5.1.4 Drainage System Components

Following are the components of a drainage system:

- Drainage Pipes
- Trap
- Drain Line
- Sanitary Fittings

Fig 5.8 Components of drainage system

1. Drainage Pipes

A pipe is a tubular section or hollow cylinder, usually but not always with a circular cross-section, that is used to transport flowable substances such as liquids and gases (fluids), slurries, powders, and masses of tiny solids.

The following types of pipes are used in the drain-

I. Corrugated drain pipes

II. PVC drainage lines

III. Cast iron pipes

IV. Copper pipes

V. Galvanized pipes

VI. Concrete or clay drainage pipes

Fig 5.9 Drainage Pipes
Source: Indiamart

2. Trap

A trap is a depressed or bent fitting that, when given, constantly remains full of water, preserving the water seal. It prevents bad gases from passing through.

3. Drain Line

Drain lines are pipes that run through your home and connect to plumbing fixtures such as toilets, sinks, and showers.

Fig 5.10 Drain Trap
Source: Indiamart

Fig 5.11 Drain Line

Source: https://lakecookplumbing.com/ten-warning-signs-that-your-main-sewer-line-needs-help/

4. Sanitary Fittings

The following types of sanitary fittings are used in any building:

I. Washbasin

This fitting is used for cleaning utensils, brushing, etc to dispose of the wastewater after use.

II. Water closet

A toilet is a piece of sanitary hardware that collects human urine and excrement, as well as occasionally toilet paper, for disposal.

Fig 5.12 Washbasin
Source: Indiamart

Fig 5.13 Water closet
Source: Indiamart

III. Urinal

A urinal is a sanitary plumbing item that is only used for urination (peeing).

IV. Bathtub

A bathtub, often known as a bath or tub, is a water-holding container in which a person or animal can bathe.

Fig 5.14 Urinal
Source: Indiamart

Fig 5.15 Bathtub
Source: Indiamart

5.1.5 Various Types of Drainage Piping Systems

A drainage system is made up of pipes that transport sewage, rainwater, or other liquid waste to a site of disposal, which could be the sewer system or a septic tank. Its primary goal is to collect and eliminate wastewater while keeping sewer gases out of the structure. There are four types of drainage pipe systems such as - Surface drain system, Subsurface drainage system, Slope drainage system, and Downspouts and Gutter Systems. In any building, house, or commercial building various types of pipes are used in the drainage pipe.

Different types of pipes used in drainage system are explained below:

- **PVC pipes** are the most commonly used pipes for any drainage project.
- **Concrete pipe** is a rigid pipe that provides both structure and conduit when it arrives on site.
- Polyethylene pipe is often used as the pipe of choice for municipal engineering, mainly used in urban water supply, and sewage treatment industry.

Fig 5.16 PVC Drainage Pipes
Source: https://www.istockphoto.com/photos/pvc-pipe-in-drainage-trench

Fig 5.17 Concrete Drainage Pipes
Source: Indiamart

Fig 5.18 Polyethylene Drainage Pipes
Source: Indiamart

5.1.6 Different Pipe Fittings

Different pipe fittings and their functions are explained in **Module 2- Unit 2.2.3 Pipe Fittings.**

5.1.7 Types of Drainage Piping Systems and their Components

House Drainage or Building Drainage refers to the mechanism established in a house or building for collecting and transferring wastewater through drain pipes by gravity to either a public sewer or a domestic septic tank. House drainage is provided to:

- Maintain healthy building conditions.
- Dispose of wastewater as soon as feasible.
- Avoid the entry of foul gases from the sewer.
- Promote speedy removal of foul matter.
- Collect and eliminate waste items systematically.

5.1.8 Principle of Drainage System

For an efficient house drainage system, the following principles are followed:

- Drainage pipe should be installed along the side of the structure rather than beneath it.
- All drains should be straightly oriented between inspection chambers. As a result, sudden turns and junctions should be avoided when passing through chambers.
- The drain slope should be sufficient to create self-cleaning velocity.
- All connections must be watertight.
- The drainage system should have an adequate number of traps in strategic areas.
- The drain size should be sufficient to prevent flooding when managing the maximum flow.
- Air lock formation, siphon-age, under deposits, and so on should be avoided.
- The lavatory bricks should be placed so that the drainage line is as short as possible.

5.1.9 Drainage System Components Used in Various Houses/Buildings

1. **Pipes**

   Depending on the role of a pipe in a house drainage system, it may be designated as follows:

   I. **Soil pipe:** A soil pipe is a pipe that transports human excreta. The size of the soil pipe is 100 mm.

   II. **Waste pipe:** This is a pipe that only transports liquid waste. It does not transport human waste. In this horizontal laying pipe size is 30 to 50 mm and the vertical laying pipe size is 75 mm.

   III. **Vent pipe:** This is a pipe that is provided for the system's ventilation. A vent pipe is open at the top and bottom to allow filthy gases to escape. It is 1 meter higher than the roof. The size of the soil pipe is 50 mm.

   IV. **Rainwater pipe:** This is a pipe that only conveys rainwater. The size of the soil pipe is 75 mm.

   V. **Anti-siphonage pipe:** This is a pipe inserted in the house drainage to keep the water seal of traps intact. There are two types of pipe laying- connecting soil pipe is 50 mm and Connecting waste pipe is 40 mm.

2. **Trap**

   A trap is a depressed or bent fitting that, when given, constantly remains full of water, preserving the water seal. It prevents bad gases from passing through.

   Characteristics of trap

   - It must be self-cleaning.
   - It must be made of a non-absorbent material.
   - Its internal and external surfaces should be smooth to prevent debris from adhering to them.
   - It should be free of any internal projections so that the flow is neither impeded or slowed.
   - It should be inexpensive and widely available.

Classification of trap

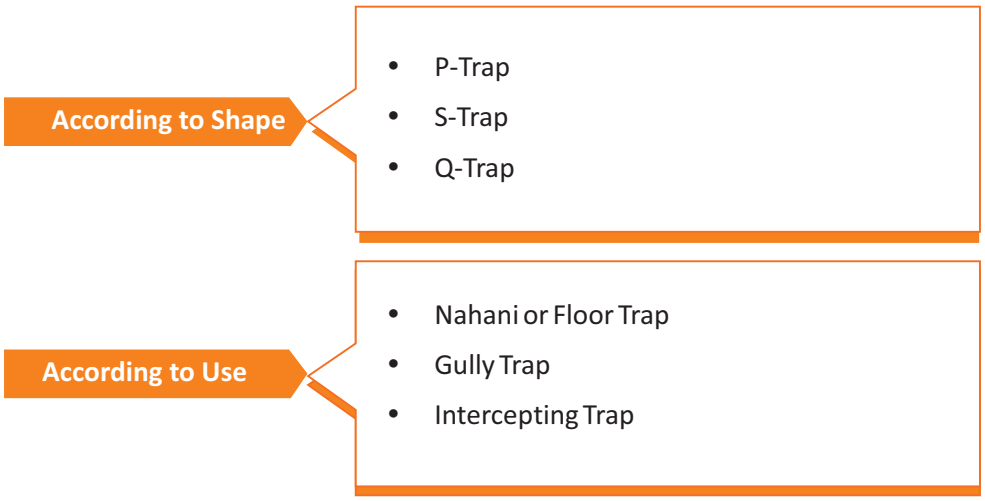

Fig 5.19 Classification of trap

a) According to shape

- **P-Trap:** This is similar to the shape of the letter P, with the legs at right angles to each other.
- **S-Trap:** This is similar to the shape of the letter S, with both legs parallel to each other and discharging in the same direction.
- **Q-Trap:** Half-S-trap is another name for it. This is similar to the shape of the letter Q, with two legs meeting at an angle different than a straight angle.

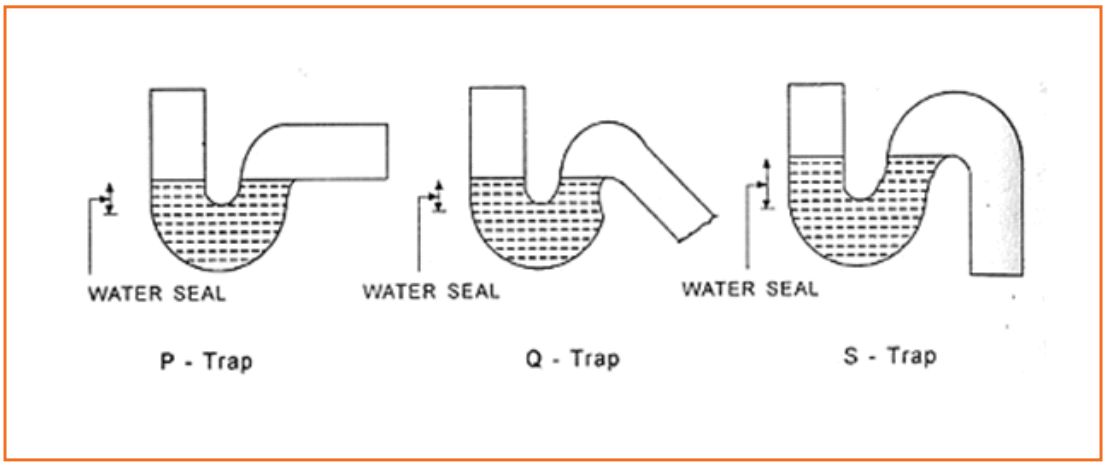

Fig. 5.20 P, S, and Q Traps
Source : http://www.pelagan.com/hyzx.php

b) According to use

- **Nahani or Floor Trap:** It collects wash water from floors, kitchens, and bathrooms. It is built of cast iron and has gravity at the top to keep large solid materials out. The cover can be removed to clean the traps on a regular basis. It features a little water seal.
- **Gully Trap:** This trap separates sullage drain (collected from bathtubs, kitchens, and other areas) from the main drainage system. It's constructed of stoneware and cast iron. The stoneware trap is square, whereas the cast iron trap is circular. It could have a P-Trap or an S-Trap. Gully traps are installed on the outside of a wall and service two or three connections from nahani traps.

Fig. 5.21Nahani or Floor Trap
Source: Indiamart

Fig. 5.22 Gully Trap
Source: Indiamart

- **Intercepting Trap:** An intercepting trap is a type of trap that is installed at the intersection of a house drain and a public sewer. It has a 100 mm deep water seal, which prevents foul gases from entering the house drains from the public sewer line. It has a cleaning eye/rodding arm hole at the top for periodic cleaning.

3. Sanitary Fittings in House Drainage

Different types of sanitary fittings are explained in **Module 2-Unit 2.2.6 Fixtures.**

Fig. 5.21Nahani or Floor Trap
Source: Indiamart

5.1.10 Characteristics and the Application of Different Pipe Fittings, Fixture Supports and Fastening Hardware

I. Pipe Fittings

In the manufacturing industries, a fixture is a work-holding or support device. Fixtures are used to securely place (position in a certain location or orientation) and support operations, guaranteeing that all parts produced using the fixture are conformant and interchangeable. In house or in any building following types of pipes fittings and fixtures are used.

Types of pipe fittings and their purposes:

- **Elbows:** To alter the angle or direction of a pipe run. 900 and 450 turns are the most prevalent. The fitting's sweep specifies how quickly a transition or change in direction occurs.
- **Street Elbows:** The pipe fitting has male threads on one end and female threads on the other. These are frequently found in galvanized steel and copper pipe. They are convenient because they eliminate the need for a nipple and perform well in small spaces.
- **Tee Fittings:** These are shaped like the letter T. Branch lines are possible.
- **Couplings:** Used to connect two straight sections of the same diameter pipe.
- **Reducers:** Used to connect pipes of varying diameters. Changes in diameter gradually.
- **Bushings:** Used to reduce the diameter of a pipe fitting. They vary from reducers in that they make a sharp shift in diameter while taking up little space.
- **Unions:** Used to link pieces of pipe when pipes cannot be twisted or when equipment must be withdrawn for maintenance or replacement.
- **Adaptor Fittings:** Used to convert a non-threaded pipe's end to male or female threads as needed. The most prevalent application is in copper and plastic plumbing jobs.
- **Caps:** These are used to seal the termination of a dead-end pipe.
- **Plugs:** Utilized to shut a pipe fitting end that is generally used for inspection or cleaning.
- **Nipples** are short sections of tubing that are threaded on both ends.
- **Wyes:** These are typically used to obtain access to DWV (drain-waste-vent) systems from the inside.
- **Valves:** These are devices that regulate the flow of liquid or gas through or out of a pipe. (For example, compression valves, ball valves, sleeve-cartridge valves, ceramic disc valves, and so on.)
- **PVC Fittings:** Available in a number of configurations and can be glued (S) or threaded (T) (T).
- **Copper Tubing Fittings:** Compression fittings should be used. Couplings, ells, and tees are common fittings

I. Fixtures

A fastener, often known as a fastening, is a piece of hardware that mechanically attaches or affixes two or more items together. Fasteners are typically used to construct non-permanent couplings or joints that can be removed or dismantled without causing damage to the joining components. Welding is one method of making permanent joints.

II. Fixtures

A fastener, often known as a fastening, is a piece of hardware that mechanically attaches or affixes two or more items together. Fasteners are typically used to construct non-permanent couplings or joints that can be removed or dismantled without causing damage to the joining components. Welding is one method of making permanent joints.

Fig. 5.24 Tools used for Fastening

Tools used for Fastening

Following are the tools used for fastening:

- Screwdrivers
- Spanners
- Sockets and keys
- Ratcheting, air-powered, or electrical tools can also be used.
- Many fasteners, such as bolts and rivets, require holes to be drilled before they can be installed.

5.1.11 Jointing Techniques

Adhesive bonding, brazing, CSST, flanged, grooved, heat-fusion weld, hubless coupling, mechanical, PEX, press, quick connect, solder, solvent weld, SV gasket, threaded, and welding are all common joining methods.

The most common method of joining pipes:

Butt Welding: The most common type of pipe joining welding method is a butt weld. This procedure is used by workers to connect two pipes of the same diameter. These couplings are particularly common in commercial or industrial pipe systems.

Fig. 5.25: Jointing of pipe

Fig. 5.26: But weld

Source : https://www.shutterstock.com/search/butt-welded

Fixing of drainage pipe: The fixing of drainage pipes is an important stage in the installation of general utilities. In addition to experience, you must be familiar with standard engineering documentation in order to establish the pipeline in accordance with all standards.

Fig. 5.27: Fixing of pipe
Source: Indiamart

The installation drainage system can be concealed (concealed mounting) and open (fixing pipes to the wall).

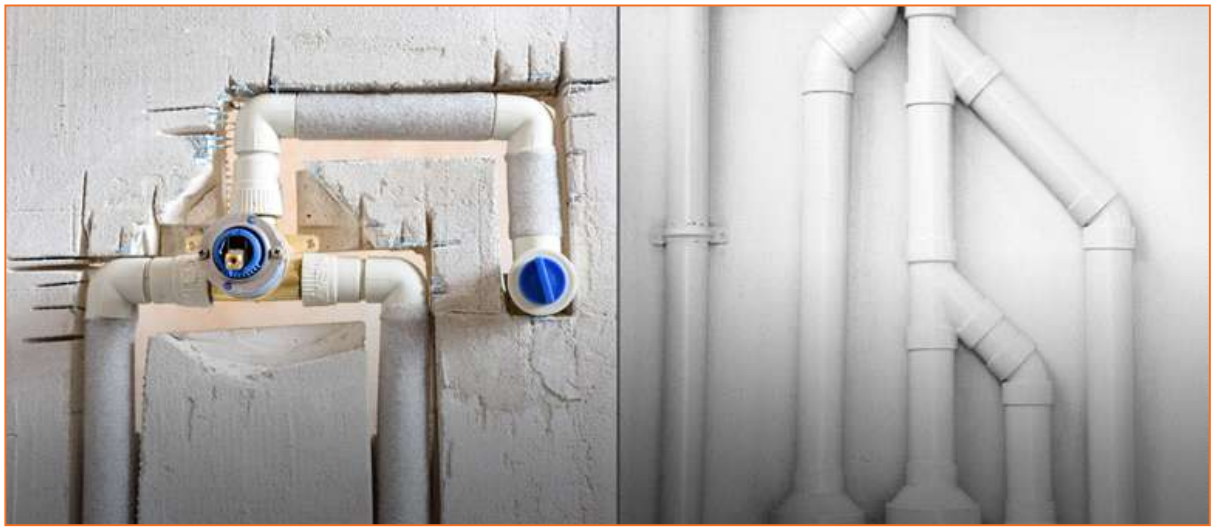

Fig. 5.28 Concealed Mounting (Left), Open Mounting (Right)

Source : https://www.zameen.com/blog/concealed-exposed-plumbing-home.html

The advantages of concealed mounting are listed below:

- Increased usable space
- Aesthetic appeal
- Low chance of harm

The advantages of open mounting are listed below:

- Simple installation
- Simple repair
- Versatility

Fixing drainage pipes

The installation process begins with the selection of pipes and fittings. Plastic pipe fasteners and cast-iron pipe fasteners must endure operating pressure and rising pressure.

Fig. 5.29: Fixing of drainage pipe

Proper fasteners for drainage pipes ensure the proper operation of the pipeline system, thus familiarize yourself with current standards before installing the pipeline. Proper fasteners for drainage pipes ensure the correct operation of the pipeline system, so before the installation pipeline, you should familiarize with. For reliable fixation of the drainage pipeline mounting clamps are most commonly used, which perform several functions:

- Do not allow the structure to deform under load.
- They account for the thermal expansion of plastic pipes.
- Noise absorption
- Adjust the pipe's distance from the wall or, if the pipes are mounted to the ceiling, the pipe's mounting height.

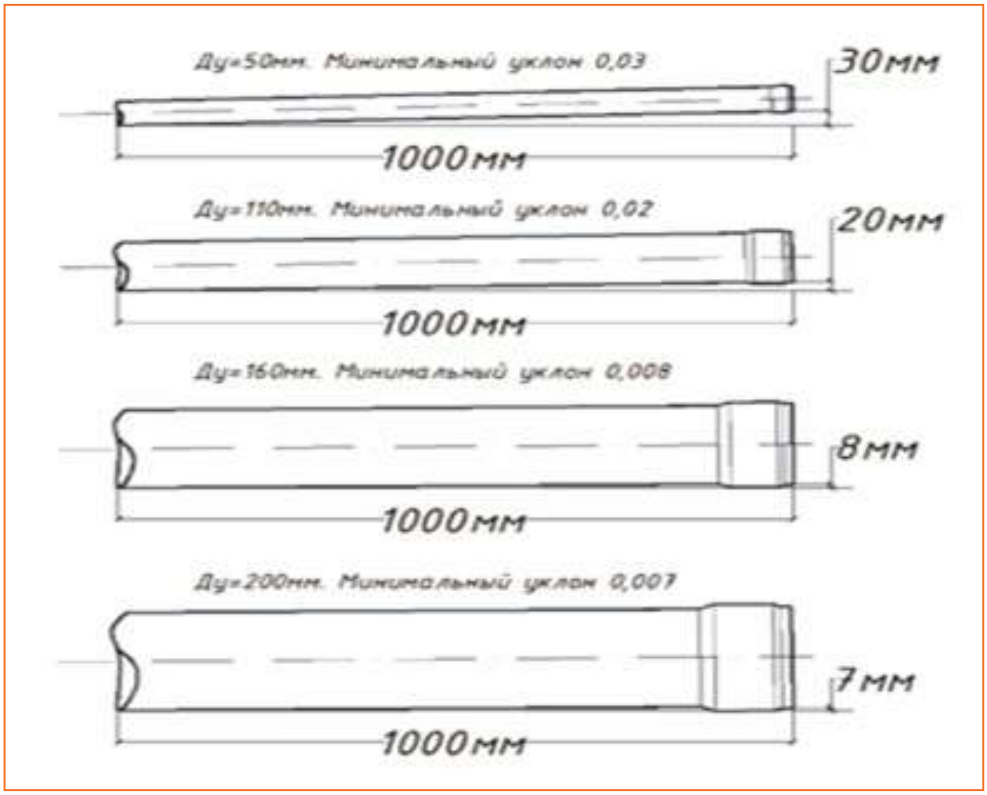

Fig. 5.30: Pipe's mounting height

As a result, the internal drainage system installation is separated into the following stages:

I. Choosing the pipe material and installation type;

II. Calculating the deviation;

III. Choosing a fastening step;

IV. Choosing appropriate mounting clamps;

V. Pipeline scheme and marking preparation.

This preliminary stage has been finished. The fasteners must be chosen next because they are critical to the system's proper operation.

Fasteners for drainage pipe installation: Drainage pipes are secured to the wall or ceiling using special clamps. For rigid fixation, the clamp is selected with pipe diameter, and if you need to keep the axial direction of the system, choose a clamp with bigger diameter, which can compensate for thermal expansion of plastic pipes. The distance between drainage pipe clamps is determined by technical criteria (diameter, flow volume etc.). There are different types of brackets for mounting of drainage pipes which are characterized by optimal low index of thermal expansion and resistance to fire.

5.1.12 Allowances for Fabrication of Pipes

Spring back: The elastic recovery of the sheet after unloading is referred to as spring back in bending. This indicates that after the sheet is bent to a bend angle (qBi) and the punch is removed, the sheet's final bend angle is increased to qBf.

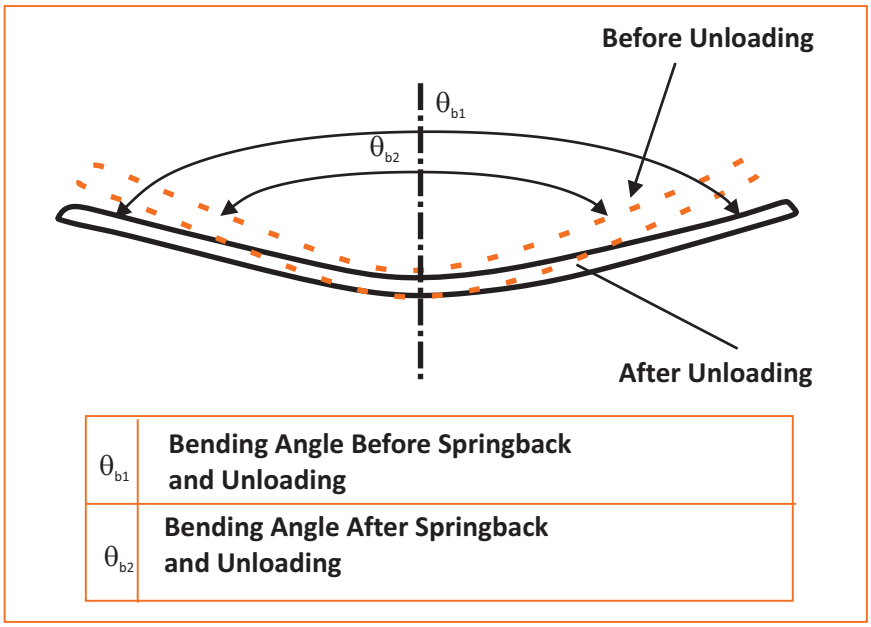

Fig. 5.31: Spring-back

Source : https://www.thefabricator.com/stampingjournal/article/bending/bend-allowance-and-springback-in-air-bending

Spring back in fabrication: Spring back is the geometric change made to a part after it has been released from the forces of the forming tool at the end of the forming process. Deep-drawn and stretch-drawn parts bounce back during sheet metal forming, affecting the dimensional accuracy of a completed part.

Remedies of spring-back: Spring-back can be easily overcome by repeatedly bending the material. However, doing so might cause metal fatigue, a condition in which the material is weakened or damaged at the point of bending. Increased forming force: To overcome spring-back, the force put on the material during bending can be increased.

Compensate for spring-back effect in bending: Spring-back happens when a substance seeks to return to its original shape after being bent angularly. To compensate for spring-back, an operator will overbend to the bending angle, which is angularly past the needed bent angle, when fabricating on the press brake.

Bend allowance: The bend allowance is defined as the arc length of the bend measured along the material's neutral axis. The bend deduction is defined as the difference between the bend allowance and twice the outer setback.

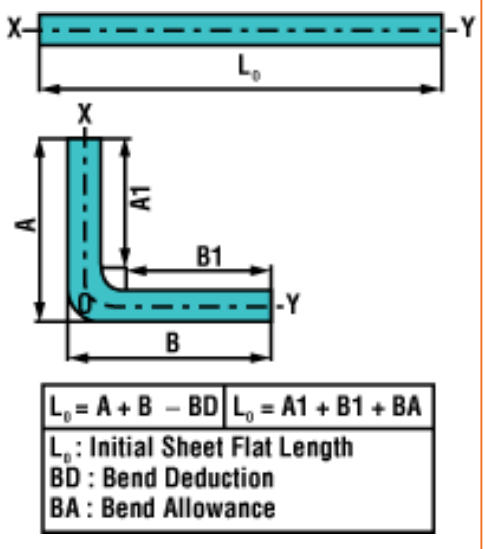

Fig. 5.32: Bend Allowance

Source

https://www.thefabricator.com/stampingjournal/article/bending/bend-allowance-and-springback-in-air-bending

Fabrication Tolerances: In practice, assuming that the weld preparations can be made exactly as necessary is unrealistic, and dimensional limitations must be tolerated, as with other engineering tasks. Tolerances are required due to the following sources of dimensional variation:

- Thickness, straightness, and flatness of the material.
- Tolerances for material cutting.
- Subassembly fabrication tolerances.
- During welding, thermal expansion occurs.
- Errors that accumulate during erection.

5.1.13 Installation Procedure of Various Types of Drainage Systems

Drainage systems encompass all plumbing on private or public property that transports sewage, rainwater, and other liquid waste to a place of disposal. The primary goal of a drainage system is to collect and eliminate waste matter in a systematic manner in order to maintain healthy conditions in a structure.

A sanitary sewer is an underground pipe or tunnel system that transports sewage (but not stormwater) from dwellings and commercial buildings to a sewage treatment plant or disposal. The following procedures are involved in the designing and construction of sewage lines:

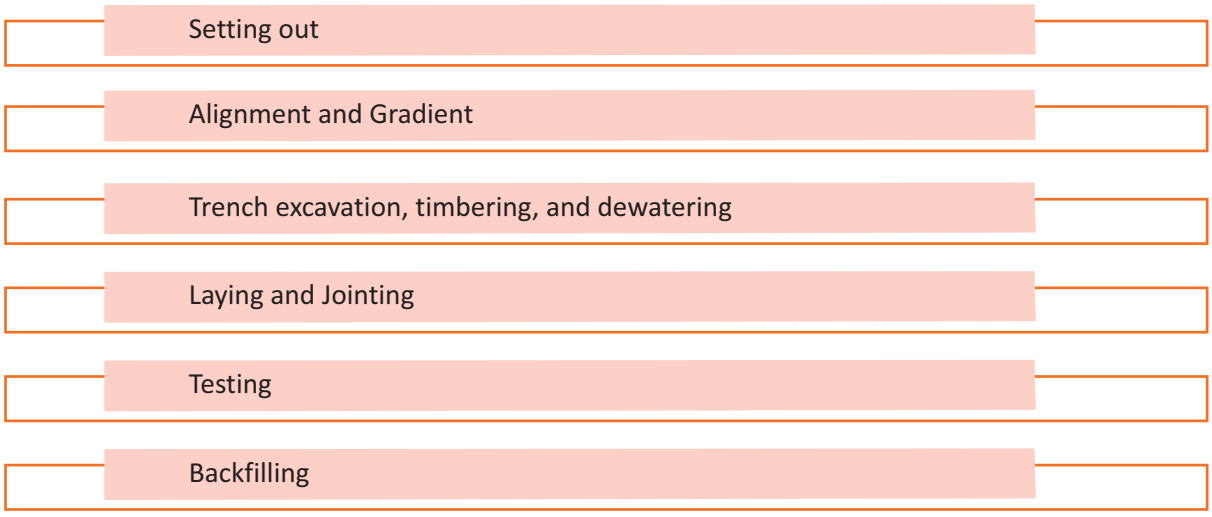

Fig. 5.33: Procedures of designing and construction of sewage lines

Design of sewer line

Sewer line design entails estimating runoff from a sewer and other hydraulic structures in the drainage system. The flow of design that can safely pass through a specific structure is referred to as design flow. The possibility of occurrence has been fixed in determining this design flow.

- **Sanitary Sewer Design:** The majority of sewer systems are built to take advantage of gravity flow. As a result, their layout is highly influenced by topography, with sewage lines sloping downward toward a wastewater treatment plant located at a lower elevation than the tributary system.

  The installation process of the drainage system

  I. Start digging. Make a massive hole.

  II. Construct the dry well. Make the dry well.

  III. Install the dry well. After wrapping the sidewalls with silt-blocking landscaping fabric, lower the dry well into the hole.

  IV. Attach the drain tube.

  V. Cover the tube in the fabric.

  VI. Connect the downspouts to the drain line in step.

  Installation of underground gutter drainage

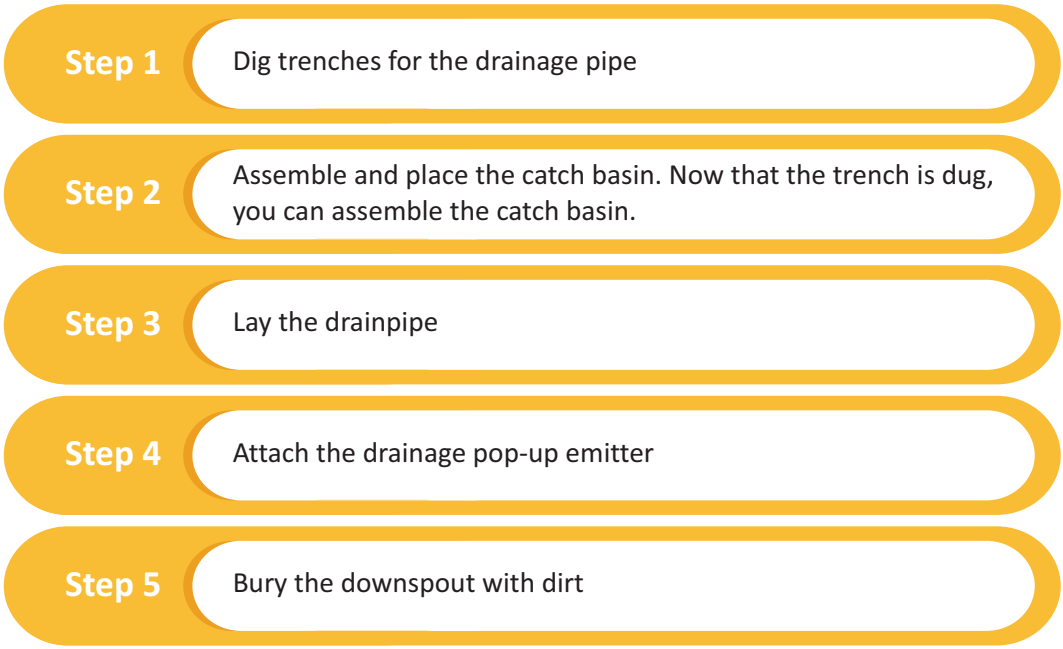

Fig. 5.34: Installation procedure of underground gutter drainage

Notes

5.1.14 Identification of Traps

Traps are fittings installed at the extremities of soil and waste pipes to prevent bad gases from drains entering the interiors of houses or buildings. This is possible because a trap is essentially a U-tube that is always of with water and so maintains a water seal. The depth the of water seal is the vertical distance between the crown and the trap's dip. The depth of the water seal symbolises the trap's strength or effectiveness. The ability of the water seal to withstand the passage of air or gas through it determines the trap's strength, which is determined by the vertical height to which water in the trap can rise above the dip to resist this passage. As a result, the deeper the water seal, the more effective the trap. In practice, water seal depths range from 25 to 75 mm, with 50 mm being very common.

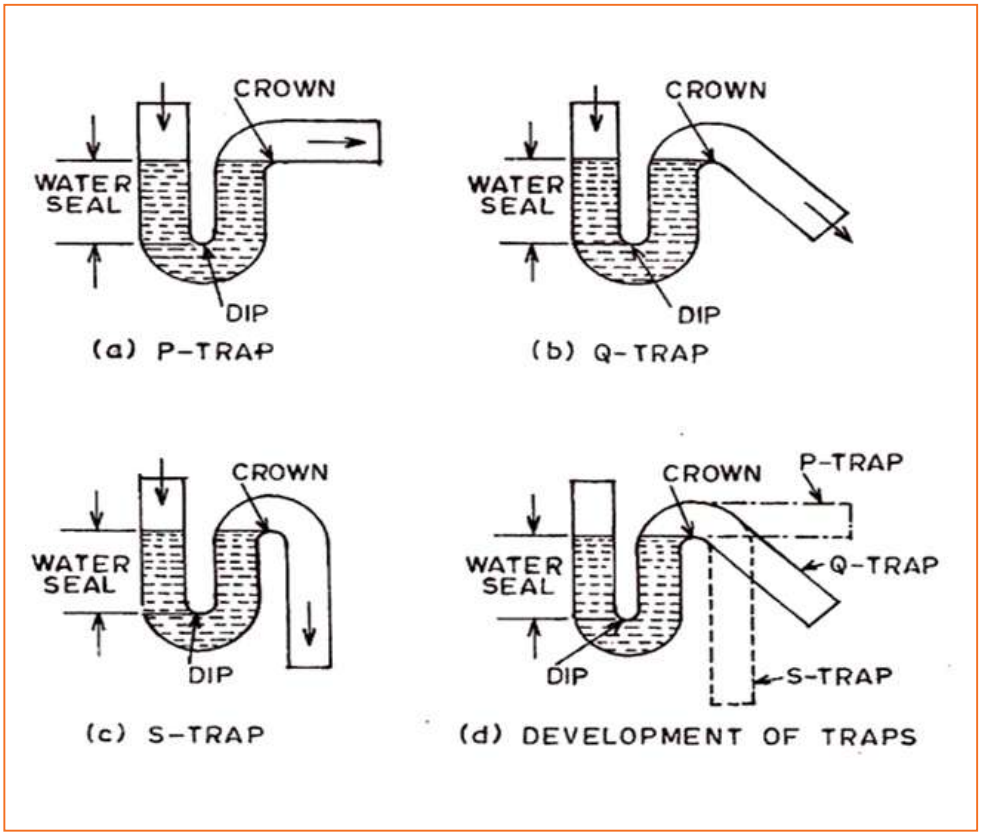

Fig. 5.35: Types of traps
Source : https://old.amu.ac.in/emp/studym/100005839.pdf

5.1.15 Merits and Demerits of Intercepting Traps

Merits of using intercepting traps:

i The intercepting trap prevents foul gases from entering the house drainage system because they cannot pass through the intercepting trap. If an intercepting trap is not installed, these gases will enter the house drainage system's vent pipes and disperse throughout the surrounding atmosphere, producing major air pollution.

ii The presence of the intercepting trap prevents pathogenic microorganisms found in municipal sewers from entering household drains.

Demerits of using intercepting traps:

i The presence of intercepting traps is found to have a significant impact on municipal sewer ventilation, as foul gases from municipal sewers will only find an outlet through ventilating columns, which are provided at the head of every branch sewer and other key points in the city sewerage system. As a result, if intercepting traps are provided, municipal sewers will require a significant number of ventilation columns, incurring additional costs and presenting an ugly appearance.

ii A deeper water seal may restrict the free flow of sewage. The heavier organic matter may not be hauled out of the trap and the lighter organic matter may not be immersed at the trap's intake, resulting in stagnation and decomposition.

iii Some house drains may become clogged as a result of negligence in properly securing the plug in the rodding arm, or as a consequence of bits of cloth, brushes, and other objects going into the drain and being unable to pass through the trap.

iv Cleaning the little length of pipe between the trap and the municipal sewer is challenging.

5.1.16 Different Types of Pumps Used in Sanitary and Drainage Systems

Drainage pumps are used to drain pits and deep motorway underpasses, as well as to dewater basements and courtyards that are at risk of flooding or groundwater. Float switches are typically used to start it automatically. Different types of pumps used in sanitary and drainage systems and their applications are explained below:

a) Centrifugal pump

A Centrifugal Sanitary Pump is a mechanism that moves fluids from one location to another. To move the liquids, these machines use kinetic energy stored in the motor. These pumps' primary job is to move the product and make the liquid to flow at the proper speed and force.

Fig. 5.36: Centrifugal Sanitary Pump
Source: Indiamart

Work process of sanitary pump: A centrifugal pump is made up of wheel-carrying vanes known as Impellers that revolve in an outer casing known as Casings. Liquid enters the pump at its center, known technically as the Eye, and exits tangentially. The sanitary pump's pressure head is solely attributable to the angular velocity imparted by the impeller, which is then translated into the head by the casing's unique structure. Pump efficiency is heavily influenced by the casing design or exterior shell.

Cavitation happens when the suction line pressure is too low in comparison to the vapour pressure of the pumped liquid. Cavitation in pumps cause a lower head and lower efficiency. The pump gradually stops pumping as cavitation increases.

Applications and Uses of Sanitary Pump:

- Heating and ventilation (HVAC) systems, fire protection, sprinkler systems, and pressure boosting.
- Air conditioning systems.
- Oil and gas companies, refineries, and power plants.

a) Submersible Pump

Submersible Pumps have a water-tight (hermetically sealed) motor that allows the entire pump to be submerged in liquid. Pumping sewage, wastewater, oil, draining water or slurries from construction sites and mines, irrigation, deep wells, and boreholes are all common applications.

Fig. 5.37: Submersible Drainage Pump
Source: Indiamart

The increased heat dissipation derived from the motor being surrounded by the pumped medium is a significant advantage of the submersible pump. Convection to the ambient atmosphere is the principal method of dissipating motor heat in a non-submersible pump.

Depending on the installation, this can range from extremely cold temperatures with maximum heat removal to extremely hot temperatures on a warm day, made further hotter by a confined pit or building.

Heat transmission is performed with a submersible pump through direct conduction to the relatively constant temperature fluid being pumped. This improved heat transfer system results in lower operating temperatures for the motor and its internal components, extending the motor's life.

5.1.17 Characteristics of the Flooring Used for the Installation and Levelling of a Drainage system

In a drainage system, it is very important to install and level of material properly before flooring work is done.

Characteristics of good flooring

- It should be long-lasting.
- The floor should be simple to maintain.
- It should not make any noise when walking or should be noiseless.
- The flooring must be visually appealing.
- It should be devoid of moisture.
- It should be heat and fire-resistant.
- The expense of floor upkeep should be low.

Types, Characteristics, and Application of Flooring

Floor-type	Typical applications	Characteristics
Carpet	Corridors, offices, and areas where quietness is a high priority and spills unlikely.	A carpet has a shorter life than a hard floor surface but can be a cost-effective solution in many cases. Installation should be wall-to-wall to avoid the hazard of tripping on the edges.
Concrete	External pathways, factory, and warehouse floors. Slip resistance depends on finish and wear. Use angular aggregate for pathways.	Rounded aggregate can be slippery when concrete wears.
Fiberglass grating	Factory areas where fluids are unavoidable. Use on overhead platforms and walkways is also appropriate.	This product can have grit particles molded into the upper surface to provide very good slip resistance. Fluids are very quickly drained away.
Glazed ceramic tiles	Bathrooms and toilets.	Slippery when wet, particularly with soapy water. Some slip resistance treatments are available but it is preferable not to install these products on floors.
Plastic matting	Bathrooms, standing mats.	Interlocking PVC extrusions give good drainage and slip resistance. May be hosed down or steam cleaned.
Quarry tiles and ceramic tiles	Suitable for kitchens where hot spills might occur. Also appropriate for shower rooms and toilet. Needs frequent cleaning.	Low water absorption and good resistance to chemicals. Slippery in wet conditions if smooth but can be moulded with aggregate or profiles to improve slip resistance. Special cleaning equipment like a high-pressure water spray may be needed as a build-up of grease or dirt can make these tiles slippery.
Rubber	Ramps and areas requiring extra slip resistance, stair treads. Usually with a round stud pattern.	Less effective in wet conditions. Must be well fixed down at the edges and joins to avoid a tripping hazard.

Contd.

Floor-type	Typical applications	Characteristics
Steel plate	Factory areas with very heavy traffic, or to span openings in floors. Usually with a raised pattern (for example chequer plate) which provides some slip resistance.	Tends to be slippery when wet or oily, particularly when worn.
Terrazzo	Office building foyers and pedestrian areas in shopping centers.	Gives a good appearance and wears well, but can be slippery when wet, when the excess polish is used or when dusty.
Timber	Meeting halls, gymnasiums, older factories, and offices.	Needs to be sealed to prevent the absorption of oil and water. Can be slippery when wet if highly glossed or polished.
Vinyl tiles and sheet	Light industrial environment, corridors and hospital wards. Not suitable where hot spills are likely to occur.	Easy to clean. Use in sheet form where washing is required to avoid water getting under tiles. Slippery when wet, particularly if polished. Slip-resistant vinyl with aggregates moulded in is available. Thicker, softer vinyl is more slip resistant than a hard vinyl.

Table 5.1 Types, Characteristics, and Application of Flooring

5.1.18 Importance of Conducting Post- Installation and Pre-commissioning Tests

A pre-commissioning checklist is intended to prepare a manufacturing plant for the startup, or when all new or updated systems are activated. This checklist will help you inspect control systems, wiring, sensors, field control devices, and the site communications network quickly and easily.

Fig. 5.38: Pre-commissioning
Source : https://safetyculture.com/checklists/commissioning-ultimate-collection/

Post-Installation refers to the time between the installation visit and the customer receiving the first bill generated by smart meter data for meters in credit mode or the first vend for meters in prepayment mode.

Installation Testing and Commissioning

The term "Installation, Testing, and Commissioning Report" refers to the report that will be provided by an independent third party chosen by the Employer to verify the satisfactory execution of the supply, installation, commissioning, and training for the AC Testing Laboratory.

5.1.19 Health and Safety Signs

There are health and safety signs everywhere. On construction sites, in workplaces, warehouses, hospitals, and in a variety of other settings. It is essential to know the meaning of safety signs. Such signs warn us of danger and allow us to take precautions to keep safe.

The five types of health and safety signs are as follows:

- Prohibition Signs
- Mandatory Signs
- Warning Signs
- Safe Condition Signs
- Fire Equipment Signs

Fig. 5.39 Health and Safety signs

The following table represents the various Signages related to health and safety measures:

S. No.	Signage	Message
1.		Basic floor sign to stop moving ahead
2.		Stop Look Out for Forklifts
3.		Eye safety warnings

S. No.	Signage	Message
4.		Fire exit sign
5.		Authorized personnel only
6.		Fire hose notification
7.		Caution signage
8.		No entry
9.		Caution signage
10.		Caution signage
11.		Wet floor warning
12.		Watching out for step
13.		Water-saving signage

Table. 5.2 Safety & Warning Signages

5.1.20 Maintenance Checklist of Plumbing

The steps involved in the plumbing maintenance checklist are listed below:

- Check the water pressure- Water pressure is going to be a key part of any plumbing maintenance service.
- Check the water leaks in the plumbing system, if any leaks are found then resolve them.
- Prevent the backflow.
- Check the signs of corrosion or rust.
- Check the blockages in the drain line.
- Observe whether the valves are working in condition or not.
- Check and follow all safety precautions at the workplace.
- A sample plumbing checklist is shown below:

BATHROOM 	☐ Check faucets ☐ Clear drains ☐ Test toilet ☐ Check toilet wax ring ☐ Caulk Seals ☐ Test shutof valves
KITCHEN 	☐ Inspect P-trap ☐ Clear drains ☐ Check faucets ☐ Test shutoff valves ☐ Check garbage disposal ☐ Test the dishwasher ☐ Check refrigerator lines/filters
SEPTIC & SEWER 	☐ Maintain septic system ☐ Check Sewer main ☐ Inspect vent pipes
AROUND THE HOUSE 	☐ Check water heater for leaks ☐ Branch shutoff valves ☐ Check the sump pump ☐ Check hose spigots ☐ Lawn sprinkier systems ☐ Inspect washing machine hoses ☐ Check home water pressure

Fig. 5.40 Sample Plumbing Checklist

Source : https://www.thespruce.com/plumbing-maintenance-checklist-2718687

Summary

- The drainage system is a well-organized network of drainage pipes that is utilized to dispose of human waste.
- The Gutter downspout is a vertical pipe that is attached and helps the water travel out of the gutters away from the building, ensuring that all waste is safely separated through the system.
- A drainage system keeps water from accumulating and causing flooding. It helps to move water away from the building and prevents water collection, which might stimulate mosquito breeding.
- A trap is a depressed or bent fitting that, when given, constantly remains full of water, preserving the water seal.
- Drain lines are pipes that run through your home and connect to plumbing fixtures such as toilets, sinks, and showers.
- A drainage system is made up of pipes that transport sewage, rainwater, or other liquid waste to a site of disposal, which could be the sewer system or a septic tank.
- House Drainage or Building Drainage refers to the mechanism established in a house or building for collecting and transferring wastewater through drain pipes by gravity to either a public sewer or a domestic septic tank.
- A fastener, often known as a fastening, is a piece of hardware that mechanically attaches or affixes two or more items together.
- Adhesive bonding, brazing, CSST, flanged, grooved, heat-fusion weld, hubless coupling, mechanical, PEX, press, quick connect, solder, solvent weld, SV gasket, threaded, and welding are all common joining methods.
- Spring back is the geometric change made to a part after it has been released from the forces of the forming tool at the end of the forming process.
- The bend allowance is defined as the arc length of the bend measured along the material's neutral axis.
- Drainage pumps are used to drain pits and deep motorway underpasses, as well as to dewater basements and courtyards that are at risk of flooding or groundwater.
- A Centrifugal Sanitary Pump is a mechanism that moves fluids from one location to another.
- Submersible Pumps have a water-tight (hermetically sealed) motor that allows the entire pump to be submerged in liquid.
- A pre-commissioning checklist is intended to prepare a manufacturing plant for the startup, or when all new or updated systems are activated.
- There are health and safety signs everywhere. On construction sites, in workplaces, warehouses, hospitals, and in a variety of other settings.

Exercise

1. What do you mean by “Drainage system”?

2. List the components of the drainage system.

3. What types of traps should be installed in the drainage system?

4. List the various types of pumps used in sanitary and drainage systems, as well as their applications.

5. What safety precautions should be taken during drainage work?

Notes

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WATER MANAGEMENT AND PLUMBING SKILL COUNCIL

6. Install Plumbing Fixtures

Unit 6.1 - Types of Plumbing Fixtures

Unit 6.2 - Plumbing Fixtures Installation

Unit 6.3 - Plumbing Standards

PSC/N0133

Key Learning Outcomes

At the en d of this module, the trainee will be able to:

1. Perform the installation of sanitary fixtures, support and related accessories

Unit 6.1 Types of Plumbing Fixtures

Unit Objectives

At the end of this Unit the trainee will be able to:

1. Describe the types, characteristics, materials, finishes, uses, limitations, working principle and performance measures of various plumbing related fixtures
2. List the accessories, supports and fasteners required for installing various types of wash basin, sinks, water closet, urinals, bathtubs and showers
3. List the sensor types of fittings and fixtures
4. Explain the basic working principal of sensor faucet and the principles of solenoid ball valves and sensors in touchless system

6.1.1 Introduction to Plumbing Fixtures

Plumbing fixtures are devices used to disperse cold or hot water or gas in bathroom or kitchen or a specific place. Fixtures are fitted at the place of use in plumbing line. A plumbing fixture may be temporary or permanent, and it need not necessarily be connected to a source of water. All plumbing fixtures are made of a smooth, non-corrosive, non-absorbent materials. These materials are anti-microbial and can be easily cleaned. It may be concluded that fixture is a part that is connected to a plumbing system and carries water in it.

Fig 6.1 Plumbing Fixtures

Source: https://www.eagertonplumbing.com/blog/2016/08/how-to-select-new-plumbing-fixtures/

6.1.2 Different Types of Plumbing Fixtures

While a fixture can be fixed into walls or the floor, a fitting is an item that can be hung by a hook, screw or nail. The most common plumbing fixtures are:

- Faucet/Tap
- Shower
- Wash Basin
- Toilet
- Flush Tank/Cistern
- Urinals
- Bath Tub

Fig 6.2 Types of Plumbing Fixtures

1. Faucets/Tap

Faucets are also known as tap. It is used to control the delivery of the water or gas. Faucets are made of various materials like plastic, stainless steel, iron or brass, zinc or zinc alloys, copper metals etc. Faucets are manufactured of various types as per design and show.

Fig 6.3 Faucet

Various types of faucets are described here.

a) **Single Lever Mixer:** This type of faucet is used to control the water and temperature. A single lever handle tap or faucet is easy to grip and turn. These are available in many designs and styles.

b) **Joystick:** Its look is different and has a different range of motion It is used to control water flow.

Fig 6.4 Single Lever Mixer
Source: Amazon

Fig 6.5 Joystick Faucet
Source: Indiamart

c) **Pushtap:** For predetermined flow of water, faucet is opened by simple push. Instead of turning handle or knob a push is given so that water start flowing.

d) **Sensor Tap:** Sensor based tap or faucet do not have handles or knobs at all. It is battery operated. It contains a passive infrared sensor to detect hand motion. These types of

Fig 6.6 Push Tap
Source: Amazon

Fig 6.7 Sensor Tap
Source: Amazon

2. Shower

It is a simple plumbing fixture with a shower head that streams cold and hot water out while you stand under it and bathe. Now days modern shower is having configurable temperature and spray pressure settings. It also has adjustable showerhead nozzle settings.

Fig 6.8 Shower
Source: Indiamart

3. Wash basin

Washbasin is a bowl-shaped fixture used for washing hands, for cleaning the utensils as well for dishwashers. Shape of washbasin may be bowl type, round, square etc. The most significant difference between the major Washbasin types is the manner in which they are installed. Wash basin are made of glazed earthenware or vitreous china or stainless steel etc.

Different types of wash basins are explained below:

a) **Wall Mounted wash basin:** Wall-mounted Washbasin are directly fitted or hanged in the wall. These wash basin takes less space and offer easy access to plumbing hook-ups. These wash basins are most suitable for small bathrooms.

b) **Pedestal washbasin:** Pedestal Washbasin is a wall-mounted Washbasin that is fixed or rests on a pedestal. It may or may not provide actual support to the Washbasin bowl. This type of washbasin does not show plumbing fittings. It is used to hide plumbing fittings etc.

Fig 6.9 Wall mounted wash basin
Source: Indiamart

Fig 6.10 Pedestal wash basin
Source: Indiamart

c) **Console washbasin** is a smooth bowl surface without corners for ease of cleaning. It is a wall-mounted washbasin that is fixed and rests on legs. The legs support the front two corners while an apron often masks the plumbing hook -ups. A small storage space can be created underneath simple by placing a basket or a shelving unit. The bowl height is designed to ensure a balanced look with tall faucets.

d) **Self-rimming wash basin:** Self-rimming wash basin consists of rimming. With the help of a rimming lip, the weight of the sink and contents to the surrounding counter are transferred. It makes basins or sinks the ability to support elevated levels of weight. In the commercial application and rough handling, saves money in the long term.

Fig 6.11 Console wash basin
Source: Indiamart

Fig 6.12 Self rimming wash basin
Source: Indiamart

e) **Integral wash basin or Sink:** This type of sink consists of a sink and a countertop all in one. Sinks integrated within a countertop are constructed of one material. Instead of the sink being an added element, it is built directly into the countertop and made from the countertop material. Integrated sinks provide a seamless aesthetic and can create a customized feel of additional luxury within a home.

Fig 6.13 Sink
Source: Indiamart

4. Toilet

It is designed to take human waste. It is connected to the soil pipe, then to a municipal sewer or septic tank, through a suitable trap. Water from the cistern tank is used to flush the excreta. There are two types of water closets:

1. Indian type
2. European type

Fig 6.14 Indian type
Source: Indiamart

Fig 6.15 European type
Source: Indiamart

I. **Indian toilets** are commonly used in India as well as the eastern part of the world. It is shaped in a way that person has to sit by foot on it. It is designed in such a way that it has slop towards the back side of the toilet where a trap excludes the sewer pipe (drain) from it. It is also known as a water closet.

II. **Western toilets** (Water closets) are very popular and commonly used in our country and the western part of the world. It is shaped like a chair and is used in the same manner. It is sloped towards the backside and also connects with the house drain through a trap. This toilet is designed in two types according to the structure. One-piece water closet in which the basin and the trap are manufactured together and whereas for two-piece water closet is manufactured in a way that the basin and trap are manufactured separately.

5. Flush Tank/ Cistern

For cleaning toilets flush tank/flushing cistern is used. It stores and discharges water for flushing of contents from a water closet (W.C.) and urinals. It is also known as a water waste preventer. It stops the wastage of water. These are used to throw water with pressure after the use of W.C. and urinals. The flush tank holds fluid in reserve for flushing. It is the tank attached to a toilet. Toilets are cleaned with the water of the flush tank by gravity.

Fig 6.16 Cistern
Source: Indiamart

Different types of cisterns are explained below:

I. Flat Type Cistern

Nowadays flat type cistern is commonly used and it is placed at a height of 3 feet above the floor. This cistern is generally composed of plastic and it has a flat valve inside. It stops the filling of water after the tank gets fully filled and starts after the tank gets vacant. It flushes out by pressing a button on it top cover.

II. Automatic Cistern

This cistern is commonly used in urinals in public places like railway stations, bus stations, theatres, malls, etc. A lot of water is used in these types of urinals. Nowadays these cisterns are mainly used.

6. Urinals

Many urinals are fitted into a wall where men or boys can urinate. These urinals do have a provision of an automatic flushing system, time flush, manual handles as well as waterless urinals.

Fig 6.17 Urinal
Source: Wikipedia

Different types of urinals are explained below:

I. **Manual Handles:** In this type of urinal, the short lever is attached to it for water flushing. It is the duty of the user to operate it systemically so that water is properly used.

II. **Timed Flush:** In this type of urinal, constant drip feed of water takes place slowly and fills the cistern. This is continued until a tipping point is reached. Now the valve opens and all the urinals attached are flushed. Similarly, electronic controllers are used for the same function.

III. **Automatic Flush:** Nowadays, electronic automatic flushes are being used to solve problems. This passive infrared sensor identifies the person standing for urination in front of it and it activates the flush. Thus, the urinal is properly cleaned. This system saves water as well as takes care of the disadvantage of manual flush.

IV. **Waterless Urinals:** In this type of waterless urinal, a trap is inserted and filled with a sealant liquid instead of water. This sealant is lighter than water and it floats on top of the urine collected in the U-bend. This prevents the release of odors into the air from the pot. The cartridge and sealant must be periodically replaced regularly.

7. Bath Tub

In the bathroom, large containers for holding water where a person may bath is known as bathtubs. In the bathtub a provision of entry and outlet is provided. Hot and cold-water taps are provided for bathing purpose. Water is drain out with the help of a waste seal trap fitted in the drain pipe. Bathtubs are designed with overflow drains on their insides where there is an opening hole. The water gets collected through the opening and drains out.

A bathtub is manufactured from many different materials like acrylic, enameled steel, and cast Iron. These materials are molded into a bathtub shape and finished. Bathtubs are manufactured in various sizes and colors. These bathtubs are scratch free in nature and can bear heavy loads also.

Fig 6.18 Bath Tub
Source: Wikipedia

Notes

6.1.3 Plumbing Accessories

Different types of plumbing accessories are explained in **Module 2- Unit 2.2 Plumbing Materials.**

6.1.4 Sensor Types of Fittings and Fixtures

I. Sensor Tap

A sensor tap is one of the most popular water flow solutions in modern times. It involves a sensor by which you can wash your hands without physically touching the equipment. In the light of social distancing, sensor taps are in trend and widely used not only in public places but also at home. The price of a sensor taps faucet ranges from Rs.9,000-Rs.13,950.

Fig 6.19 Sensor Faucet
Source: https://www.pinterest.com/pin/touchless-motion-sensor-bathroom-kitchen-faucet--420102090006211 84/

a) Benefits of Sensor Water Tap

A sensor water tap has various benefits for daily usage at home. It includes:

- educes the bacteria spread
- Hygienic way of washing your hands
- Hand-free wash which ensures less damage to the tap
- Saves 30-65% water as compared to ordinary tap faucet
- Low electricity consumption

b) Basic working principle of sensor tap faucet

Sensor taps are organized via an infrared sensor beam that is located at the bottom of the tap. This beam breaks when you place your hands in front of it that results in water flowing from the tap. Water flows through the tap for a limited period of time and then turns off automatically. This process is seamless and efficient for no-contact usage. Sensor tap faucets are also perfect for all types of bathrooms.

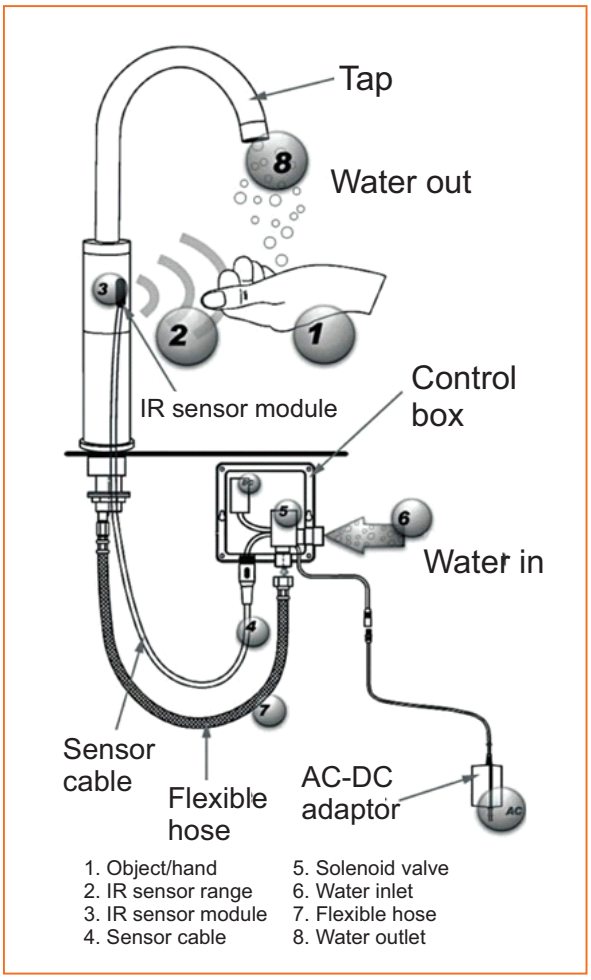

Fig 6.20 Working Principle of Sensor Tap Faucet

Source : https://www.electronicsforu.com/technology-trends/everything-may-like-know-infrared-water-faucets

c) Basic working principle of sensor faucet

A sensor faucet or automatic faucet consists of a sensor and mechanism that open its valve in the presence of the user's hands and vice versa. The infrared sensor detects when you move your hands away from the tap and automatically stops the water flow.

Sensor taps are controlled using an infrared beam emitted from a sensor (usually located on the stem). This beam is broken when hands are placed in front of it, activating water flow. Water then flows for a set period of time before automatically switching off. This does require electricity to operate, but it is very low voltage. The electricity can be wither connected to Ac of the home of battery operated.

II. Solenoid Valve

A solenoid valve is an important component of any fluid control system. It is an electro-mechanical valve that is primarily employed to control the flow of fluid (Liquid or gas). This eradicates the manual controlling of the valve which saves time and money both.

Fig 6.21 Solenoid Valve
Source: Indiamart

a) Applications of Solenoid Valve

- Specifically used for clean liquids and gases.
- These are used to close, open, dose, distribute, or mix the media with two or more inlets/outlets.
- Very fast acting.
- Commonly used in heating systems, compressed air, vacuum, irrigation, car washes, etc.

b) Working Principle of Solenoid Valve

- "An electric current through the coil creates a magnetic field. The magnetic field exerts an upwards force on the plunger opening the orifice. This is the basic principle that is used to open and close solenoid valves." A solenoid valve consists of two units: An assembly of the solenoid (the electromagnet) and plunger (the core), and a valve containing an opening in which a disc is placed to control the flow of fluid.
- The valve is opened or closed by the movement of the magnetic plunger.
- When the coil is energized, the plunger is drawn into the solenoid (electromagnet), and flow through the orifice is allowed.
- The valve returns automatically to its original position when the current ceases due to the pressure of the spring and flow through the orifice is restricted.

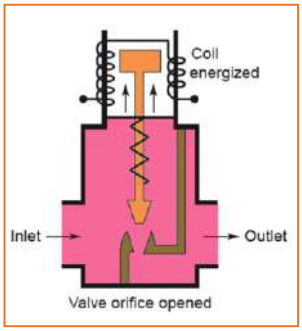

Fig 6.22 Working Principle of Solenoid Valve
Source: https://www.yourelectricalguide.com/2017/12/solenoid-valve-working-principle.html

Unit 6.2 Plumbing Fixtures Installation

Unit Objectives

At the end of this Unit the trainee will be able to:

1. Describe the correct practices for installing plumbing fixtures
2. Explain the importance of traps for the sanitary fittings, both deep seal traps and low seal traps
3. Explain the working and use of conservancy, water carriage and the combination system
4. Discuss alignment and elevation techniques used in plumbing systems

6.2.1 Correct Practices for Installing Plumbing Fixtures

Installation is the process of positioning or installing a plumbing fixture, such as a washbasin, a toilet, etc. Installation is a crucial step in aligning system components with the design. Planning is done in accordance with the established technique for designing when installing a plumbing system in a structure, a dwelling, or a housing colony. A competent installation process stops water leaks, enables the best use of the money invested, and lengthens the lifespan of the plumbing fittings. Installation guidelines are provided by the manufacturer directly or in the construction map's specifications. The installation of a plumbing system can be completed with a plumbing system that operates smoothly and effectively if the prescribed procedure is followed. Installing of plumbing fixtures like wash hand basin, water closet, sink, urinal, bath tub has been explained below:

a) Wash Hand Basin (W.H.B.)

Wash Hand Basin is designed for washing the upper parts of the body.

Wash Hand Basin can be fixed with:

- L' brackets: M.S./C.I.
- J' brackets: M.S./C.I.
- On pedestals

Below are the steps to fix wash hand basin

- Check the size, length etc.
- Drill suitable holes for brackets in the wall, at the required level, with a drill machine/punch. W.H.B. is generally fixed at 825 mm from F.F.L.
- Brackets should be fixed with 75mm screw and rubber plugs in position.
- It is advisable to fix fasteners (75mm length) in slots of W.H.B. for better rigidity.
- Fix W.H.B. on firmly fixed bracket pair.
- Additional screws should be fixed on flat back of W.H.B. for ensuring complete fixity.
- Half threaded waste coupling should be fixed with washer using tag and habak.
- Either bottle trap or P.V.C. connection should be fixed for out-flow in G.I. outlet/N.T.
- Fix pillar tap to W.H.B. and connect it to the P.V.C. inlet pipe with stop valves to the water supply line. All connection should be checked for possible leakages.

One Wash Hand Basin requires following fitting and materials:

- Wash hand basin - I No.
- Waste coupling (half threaded 32 mm) - 1 No.
- Side brackets - 2 Nos.
- 75mm screws/rolls. rubber plugs, punch/drilling machine.
- 15mm pillar tap – 1 No. (2 Nos. if hot and cold mixing arrangement is provided).
- Angled stop valve 15 mm - 1 No. (2 Nos. if hot and cold mixing arrangement is provided).
- C.P. bottle trap - 1 No.
- P.V.C. inlet 15 mm – 1 No. (2 Nos. if hot and cold mixing arrangement is provided).
- P.V.C. waste pipe (Flexible) 32mm dia - 1 No.

b) WATER CLOSET (W.C.)

- Types of water closets
- Indian style water closet (I.W.C.)
- European style (E.W.C.)
- Anglo-Indian type (A.I.W.C.)

INDIAN STYLE WATER CLOSET (OR SQUAT-TING TYPE)

- Simple In construction and working.
- The pan and trap are separate pieces.
- The flushed water enters the rim of the pan through the opening provided in front/back of the pan.
- Requires at least 10 liters of water for flushing.
- Sizes available —> 580min. 630min etc.

EUROPEAN STYLE WATER CLOSETS

- Either pedestal type supported at floor or bracket type built in to and supported on the wall.
- An efficient self-cleaning W.C.
- The pan and trap (P or S) in one piece are best for use in the building.

UNIVERSAL. OR ANGLO-INDIAN TYPE

- This is the combination at Indian and European type water closets.

One W.C. requires following fittings and materials-

- Water closet = 1 No.
- P-trap or S-trap = 1 No.
- P.V.C./C.I connector piece = 1 No.
- l5mm bib tap = 1 No.
- Flushing system (Half turn flushing cock or low-level flush tank).

c) SINKS

- Porcelain and stainless-steel readymade sinks are available in the market and can be used. Normally, built-in sink to cuddappa, marble and granite can be made at the site, while doing kitchen platform.
- Sink is a shallow rectangular basin with a flat bottom. All internal angles are rounded for easy cleaning. The bottom slopes towards the outlet for easy drain of water.
- A Full threaded coupling is used lot the outlet, which is connected to the bottle trap or P.V.C. pipe
- The sink should be fixed at a height of 585 mm above the F.F.L.

One sink requires followings fittings and materials

- Sink = 1 No.
- Waste coupling lull threaded 32mm 1 No.
- P.V.C. waste pipe 32mm = 1 No.
- 5mm C.P. bib tap (long arm) = 1 No.

d) URINALS

Most commonly used urinal is 'BOWL URINAL'

BOWL URINAL

- Individual bowls are mounted on the wall as shown in figure.
- Bowls are fixed individually with/without division pieces between.
- Material = Vitreous China
- Size = Flat back 430 x 260 x 350 mm (minimum)
- Angle back 340 x 410 x 265mm (minimum)

Urinals are flushed by automatic flushing cisterns fixed above the urinal and discharging through a flush pipe. The automatic flushing cistern is of 4.5 litter capacity per urinal and the cisterns can be adjusted to flush after every twenty minutes.

One urinal requires following fittings and materials –

- Urinal = 1 No.
- Outlet horn coupling = 1 No.
- P.V.C. outlet pipe 32mm = 1 No.
- Flushing system = 1 No.

e) BATHTUBS

- Generally, bathtubs are made of vitreous earthen ware or fiber glass. They are also available in P.V.C. or fiber reinforced plastic (F.R.P.) material with various designs and colours.
- It is provided with hot and cold-water connections and an inlet of 15mm dia each and outlet of 32mm dia, connected to waste pipe.
- The waste pipe is connected to the main vertical stack through a trap, so as to prevent the entry of foul gases in the bathtub.
- It is also provided with an overflow pipe to drain any excess water.
- Usual dimensions of the bathtub are 1.80m length x 0.75m width x 0.45m depth.

6.2.2 Importance of Traps

Traps are essential component in sanitary fitting as it stops the sewer gases produce in drainage pipes coming back into the house. Water present in the trap act as barrier to the way to foul air. Hence, all plumbing fittings like basins, bathtubs, kitchen sink and toilets etc., are provided with traps. The traps efficiency depends on the water seal depth. The depth of the seal varies from 40mm to 75 based on the design of the traps.

I. Deep Seal Trap

A deep seal trap is provided on the wall's outer face for disconnecting the wastewater flowing from the bath, kitchen, basin, and floors to the primary drainage system. The deepwater seal forms a barrier for preventing foul air from the house drain to inside the building. It is formed of cast iron or glazed stoneware.

II. Low Seal Trap

The trap serves several important purposes. The water inside the trap serves as a liquid seal that **helps keep sewer gas smells from getting out of the drains.** The water seal inside a trap is a minimum of 2" and a maximum of 4".

6.2.3 Working and Use of Conservancy, Water Carriage and the Combination System

I. Conservancy system

This system is also known as Dry system of sanitation. In this system different types of garbage or refuse are collected, conveyed, and disposed of separately by methods like burning, filling, burying, etc.

Garbage is collected in dustbins and is conveyed by trucks to the disposal point. Then, combustible & non-combustible portions are separated. Human excreta is collected separately in conservancy latrines or privies and is carried by human agencies.

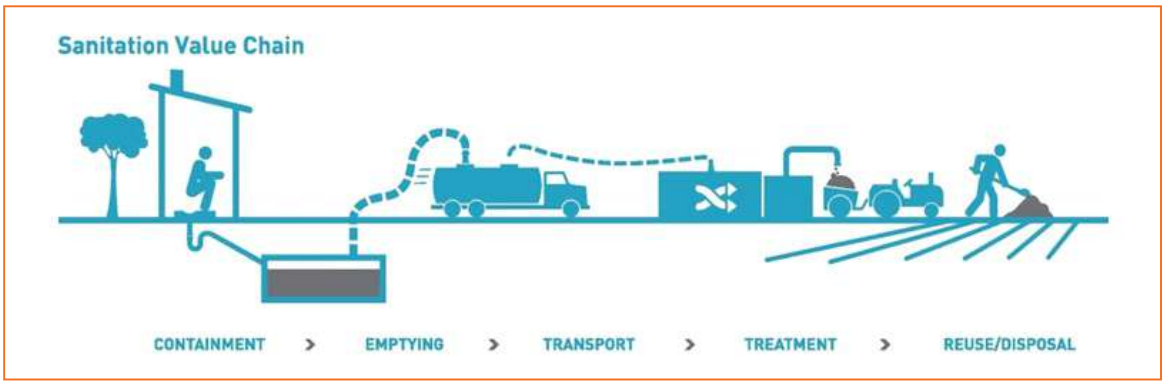

Fig 6.23 Water Conservancy System

Source : https://dreamcivil.com/conservancy-system/

Following are the features of the water conservancy system:

- This is old system in which various types of wastes, such as night soil, garbage etc. are collected separately in a vessel or deposited in a pools or pits and then removed periodically at least once in 24 hours.
- The conservancy system is highly unhygienic and causes insanitary condition.
- Transportation of night soil takes place in open carts through street and other crowded localities, this is highly undesirable.
- The working of the system entirely depends on the labor if they go on strike at least one day foul matter start creating smell which highly unhygienic.

II. Water carriage system

The water carriage system is the modern method of conveyance of sewage. In this system, water is used as a medium for conveying the sewage to the treatment plant and final disposal. In this system, the excremental matters are mixed up in a large quantity of water and carried through underground sewers to the treatment plant and suitably disposed off.

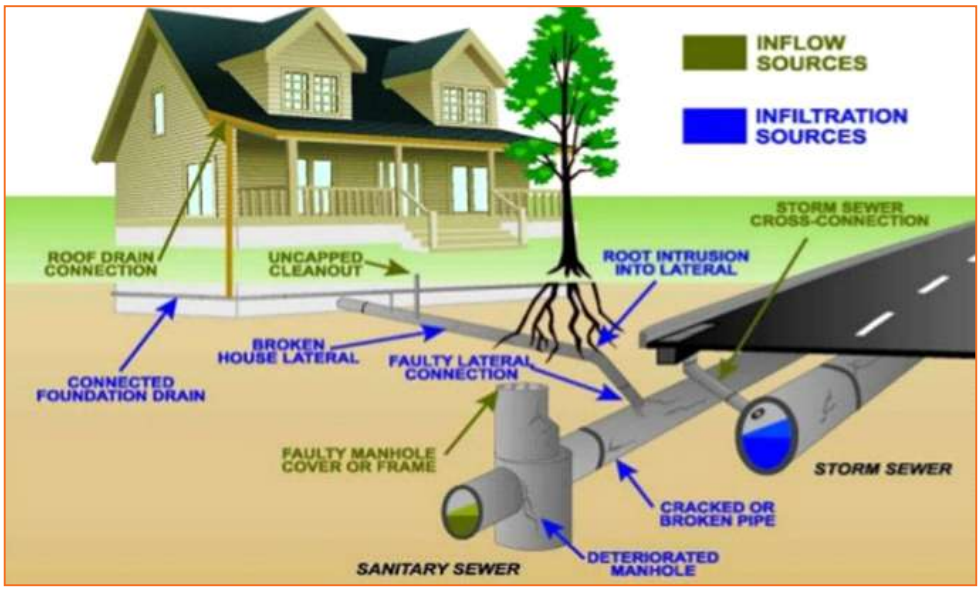

Fig 6.24 Water Carriage System

Source : https://dreamcivil.com/water-carriage-system/

Following are the features of this system:

- In this system, collection and conveyance and disposal of various wastes are carried out with the help of water.
- Sufficient quantity of water is required to be mixed with waste so that dilution ratio is so great that the mixture may flow just like water.
- This system is very hygienic as night soil and other waste carried out through closed conduit which is not directly exposed to atmosphere.
- There is no chance of outbreak of epidemic because files & other insect do not have direct access to the sewage.
- The labour required for the operation and maintenance is extremely small.
- Initial cost of installation of this system is very high, the running cost are very small.

The water carriage system is being divided into three systems:

I. **Separate water carriage system:**

In a separate system, there are two separate sewers (i.e., Foul Sewer & Stormwater Sewer). Foul sewer is also called sanitary sewer and is used to carry sewage from buildings (but not stormwater) to point of treatment. Whereas, Stormwater sewer is used to carry stormwater from roads, buildings & surfaces. The stormwater is discharged into rivers without treatment.

II. **Combined water carriage system:**

In Combined System; there is only one set of the sewer. Sewages from houses and commercial buildings as well as rainwater is carried in the same sewer. It means that the same sewer act as both sanitary sewer and stormwater sewer.

Advantages of Combined System

- It requires only one sewer. This reduces the cost of construction.
- Because of the large diameter; cleaning is easy.
- Self-cleaning velocity can be easily achieved in this method.

Disadvantages of the Combined System

- Handling and transportation of sewer is difficult.
- Load on the treatment plant is increased.
- cDuring heavy rains, it may flow out.

III. **Partially combined system:**

In this system; only one set of the sewer is there, with one overflow drain connected. When an overflow drain is added to the combined system; the partially combined system is formed.

6.2.4 Alignment and Elevation Techniques

Proper alignment in plumbing is of utmost priority if a piping system is to be correctly fabricated.

Poor alignment can cause welding difficulties and so a system doesn't works efficiently. Some simple procedure needs to be followed by the plumber, they are defined as follows –

1. **Pipe to Pipe –** Level one length of the pipe using a spirit level. Bring length together leaving only a small welding gap. By placing the spirit level over both the pipes as shown in figure and manoeuvre unpositioned length until both are levelled. Repeat the procedure if required.
2. **45 degree Elbow to pipe –** Level the pipe with spirit level. Place fitting to pipe leaving small welding gap. Place 45 degree spirit level on the face of elbow.

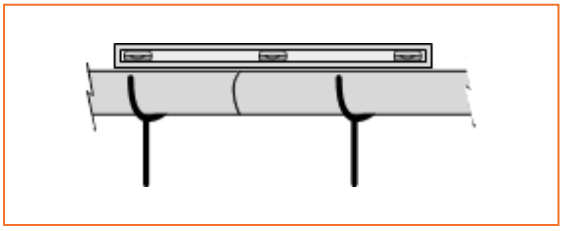

Fig 6.25 Pipe to Pipe

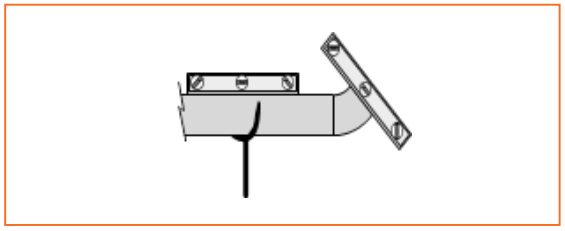

Fig 6.26 45degree elbow to pipe

3. **Tee-to- pipe –** Level using the spirit level. Place the tee to pipe leaving the small welding gap. Place the same and repeat if required.
4. **Flange –To – Pipe -** Bring flange to pipe and leave some welding gap. Align top two holes of flanges with spirit level. Centre square on face of flange as shown in figure. Check sides in the same way.

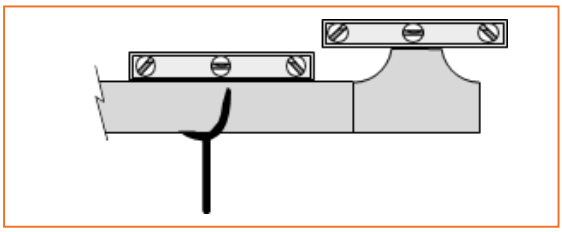

Fig 6.27 Tee to pipe

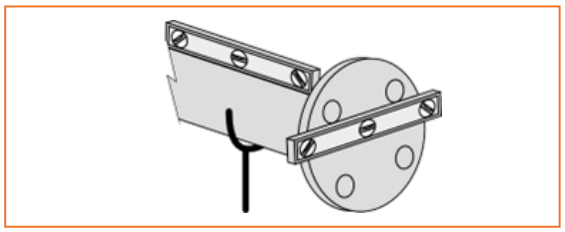

Fig 6.28 Flange to pipe

Therefore, In order to create and adhere to the required gradient or the required position, the pipes should be aligned and fixed after being installed whenever possible.

Following conditions must also be taken care of for assigning proper elevation and alignment –

- In non-man-accessible sections of the sewer to be rehabilitated, these measures are mainly limited to making the invert even before installing the pipes, the reduction of the ring gap to the smallest possible dimension or the arrangements.
- The support hose fixed to the crown of the piping is filled with water after installation so that it is supported against the inner wall of the sewer and the liner.
- A condition for the utilization of this method of fixing is roll-free insertion of the piping as well as the careful estimation of the required filling pressure also taking account the loading conditions of the liner in order to prevent longitudinal cracks as a result of too much pressure in the crown.
- In the man-accessible region, the targeted alignment and fixing of the pipes is only possible when they are individually pulled or pushed-in or when a correspondingly large annular space is available.

Notes

Unit 6.3 Plumbing Standards

Unit Objectives

At the end of this Unit the trainee will be able to:

1. List the codes, standards and regulations applicable for the installation of plumbing fixtures

6.3.1 Standards and Regulations of Plumbing

There are various standards applicable to piping installations and so different codes are assigned to them. Each country has its own standards and codes. Some of them are described as follows:

1. **The American National Standards Institute (ANSI) Standards**

   organization that administers and coordinates the U.S. voluntary standards and conformity assessment system. Some of codes related to piping system are shown below:

   ASME B31.1 – Power Piping

   ASME B31.2 – Fuel Gas Piping

   ASME B31.3 – Process Piping

   ASME B31.4 – Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids

   ANSI / ASME B 1.20.1 – Pipe threads for general purposes.

2. **British Standards**

   There are many British Standards referred by Indian Manufacturers for Piping and Valves. The most commonly referred British Standards in the Piping Industry are :

   BS 10 : Flanges

   BS 806 : Pipes and Fittings for Boilers

   BS 916 : Black Bolts, Nuts and Screws

   BS 970 : Steel for Forging, Bars, Rods, valve steel, etc.

   BS 1212 : Specification for Float Operated Valves

   BS 1306 : Copper and Copper alloy pressure piping system

   BS 1414 : Gate Valves for Petroleum Industry

   BS 1560 : Steel Pipe Flanges

3. **Indian Standards**

   Bureau of Indian Standards (BIS) have not been developed Indian standard so far for the design of Piping Systems. Hence, ANSI standards have been widely used as a reference. These standards also accept materials covered in other standards. Unlike American Standards, Indian Standards also cover dimensions and material specifications under the same standard number. Most widely used Indian standards for piping systems are as follows:

   IS 210 : Grey Iron Castings

   IS 226 : Structural Steel (superseded by IS 2062)

   IS 554 : Dimensions of Pipe Threads

   IS 778 : Specification for Copper Alloy Gate, Globe and Check Valves

   IS 780 : Specification for Sluice Valves – 50 NB to 300 NB

IS 1239 (Part I and II) : Specification for Mild Steel tubes and fittings
IS 1367 : Technical supply conditions for threaded steel fastners
IS 1536 : Centrifugally Cast Iron Pipes
IS 1537 : Vertically Cast Iron Pipes
IS 1538 : Cast Iron Fittings
IS 1870 : Comparison of Indian and Overseas Standards
IS 2062 : Steel for general structural purposes
IS 2906 : Specification for Sluice Valves – 350 NB to 1200 NB
IS 3114 : Code of Practice for laying pipes
IS 4038 : Specifications for Foot Valves
IS 5822 : Code of practice for laying welded steel pipes
IS 6157 : Inspection and Testing of Valve
IS 7806 : Stainless Steel Castings
IS 9890 : Ball Valves for general purposes
IS 10221 : Code of Practice for coating and wrapping of underground MS pipelines
IS 10711 : Size of Drawing Sheets
IS 13095 : Butterfly Valves

Advantages of Working with Code and Standards

- These form a uniformity in different engineering criteria's, principles, terms, materials etc.
- These standards helps the user to establish a standard way of working.
- This also ensures built in safety, reliability and continuity.
- Mainly it minimizes mismatch and solely promote interchangeability.

Notes

Summary

- Plumbing fixtures are devices used to disperse cold or hot water or gas in bathroom or kitchen or a specific place.
- Fixtures are fitted at the place of use in plumbing line. A plumbing fixture may be temporary or permanent, and it need not necessarily be connected to a source of water.
- While a fixture can be fixed into walls or the floor, a fitting is an item that can be hung by a hook, screw or nail.
- Faucets are also known as tap. It is used to control the delivery of the water or gas. Faucets are made of various materials like plastic, stainless steel, iron or brass, zinc or zinc alloys, copper metals etc.
- Now days modern shower is having configurable temperature and spray pressure settings. It also has adjustable showerhead nozzle settings.
- Washbasin is a bowl-shaped fixture used for washing hands, for cleaning the utensils as well for dishwashers.
- Pedestal Washbasin is a wall-mounted Washbasin that is fixed or rests on a pedestal. It may or may not provide actual support to the Washbasin bowl.
- Console washbasin is a smooth bowl surface without corners for ease of cleaning. It is a wall-mounted washbasin that is fixed and rests on legs.
- Indian toilets are commonly used in India as well as the eastern part of the world. It is shaped in a way that person has to sit by foot on it.
- Western toilets (Water closets) are very popular and commonly used in our country and the western part of the world. It is shaped like a chair and is used in the same manner.
- For cleaning toilets flush tank/flushing cistern is used. It stores and discharges water for flushing of contents from a water closet (W.C.) and urinals.
- In the bathroom, large containers for holding water where a person may bath is known as bathtubs. In the bathtub a provision of entry and outlet is provided.
- A sensor tap is one of the most popular water flow solutions in modern times. It involves a sensor by which you can wash your hands without physically touching the equipment.
- Sensor taps are organized via an infrared sensor beam that is located at the bottom of the tap.
- A sensor faucet or automatic faucet consists of a sensor and mechanism that open its valve in the presence of the user's hands and vice versa.
- A solenoid valve is an important component of any fluid control system. It is an electro-mechanical valve that is primarily employed to control the flow of fluid (Liquid or gas).
- Installation is the process of positioning or installing a plumbing fixture, such as a washbasin, a toilet, etc. Installation is a crucial step in aligning system components with the design.
- Traps are essential component in sanitary fitting as it stops the sewer gases produce in drainage pipes coming back into the house.
- Proper alignment in plumbing is of utmost priority if a piping system is to be correctly fabricated.
- There are various standards applicable to piping installations and so different codes are assigned to them. Each country has its own standards and codes.

Exercise

1. Explain the meaning of plumbing fixtures?

2. List common plumbing fixtures used in a home.

3. What is the purpose of faucet? List the different type of faucet

4. Discuss the importance of wash basin. List the different type of wash basin.

5. List the different types of standards used in plumbing

Notes

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
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Corporation
Transforming the skill landscape

WATER MANAGEMENT AND PLUMBING SKILL COUNCIL

7. Troubleshooting and Maintenance for Plumbing

Unit 7.1 - Plumbing Systems Troubleshooting and Maintenance

PSC/N0142

Key Learning Outcomes

At the en d of this module, the trainee will be able to:

1. Demonstrate how to inspect of domestic plumbing systems and fixtures to identify faults
2. Perform repair and maintenance activities

Unit 7.1 Plumbing Systems Troubleshooting and Maintenance

Unit Objectives

At the end of this Unit the trainee will be able to:

1. List the various types of faults (such as leakages, improper joints, broken sewer; dripping faucets and water lines, etc.) associated with plumbing systems (such as aerators, septic systems etc.)
2. List the testing procedures to be performed to check proper functioning of the fixtures and pipework installed
3. State the remedial and preventive measures for common plumbing problems with respect to fixtures, pipes and fittings
4. Discuss correct practices for troubleshooting and maintenance for plumbing fixtures and systems
5. Explain the application of mechanical and hydraulic principles for clearing blockages
6. List the methods of corrosion protection such as coatings and tape
7. Discuss common organisational policies related to costing, scheduling, procurement and documentation for plumbing maintenance and repair work

7.1.1 Introduction to Troubleshooting

Plumbing troubleshooting is an important first step to making successful repairs. If the right reason hasn't been found, you can waste time and money on futile initiatives. Plumbing issues come in all sorts of shapes and sizes. This can range from minor and inexpensive works such as dripping faucet to enlarged issues such as major pipe leak etc. As said, Prevention is better than cure, so one can minimize the chances of problems from occurring. Most common faults associate with plumbing systems are as follows:

- Low Water Pressure
- Dripping Faucets
- Leaky Pipes
- Slow or Clogged Drainge
- Running Toilets
- Leaking House Bib
- Slow Draining Sink/Tube
- Clogged Bath
- Jammed Garbage Disposal

Fig 6.2 Types of Plumbing Fixtures

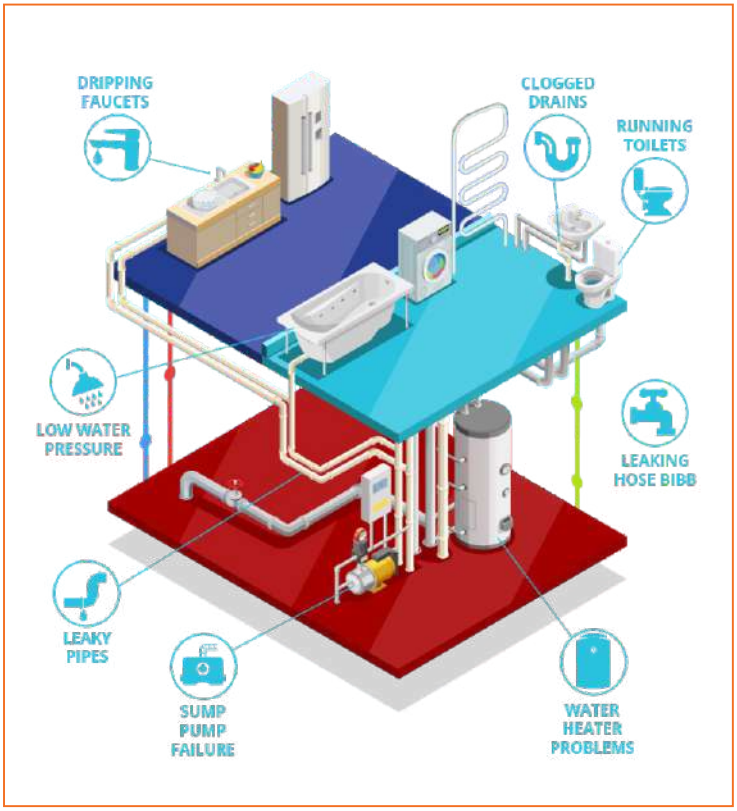

Fig 7.2 Common Plumbing Problems Around Home
Source : https://lentheplumber.com/blog/common-plumbing-problems/

7.1.2 Testing Procedures

A plumbing inspection is carried out by a certified plumber or plumbing consultant. Proper inspection helps in quality and safety. Following are the important elements of plumbing inspection checklist for plumbing system:

a) Pipes

Pipes are connecting members of the whole plumbing system. Any damage to these pipes will affect the whole plumbing system and to repair or replace pipes is not easy once in use.

Following checks to be carried out while inspecting pipes:

01. Pipes should not have rust formation.
02. In case of plastic pipes, the plastic used in pipe should be permissible.
03. All lead pipes should be replaced as lead is harmful.
04. Turn on all faucets and check for noisy pipes if any.
05. Check for leakage is done by these two tests:

I. **Pneumatic Pressure Test:** Perform air pressure test on pipes. It is a way of checking for leaks in the water pipes without actually having any water in the pipes. Connect an air compressor to the water piping, typically at the laundry faucet or exterior sillcock. Turn off all the faucets. Now pressurize the pipes to about 60psi or 4.1kg/cm2. Wait for minimum 30 min to check if there's any pressure drop. Pressure drop is an indication of leakage in pipes.

II. **Hydraulic Pressure Test:** Remove all air from the system through valves and fixtures. Plug or seal all openings and close all valves. Now fill the pipe system with water and pressurize it to specified pressure i.e. 6 kg/cm2 (85 psi). Take a walk around the pipelines that are accessible and observe noisy pipes if any or check for leaks. Then check the pressure, if there's any pressure drop, then it is the indication of leaky pipes, else the pipes are leakage free.

b) Faucets: Faucets are commonly known as taps. Check carefully every faucet or faucet assembly. Faucets should neither be corroded nor should be leaking. Even check for faucet handles that they aren't jammed.

c) Fixtures: It includes sinks, bathtubs, showers, laundry tubs, sill cocks. All fixtures should be placed correctly and firmly fixed. There should be no leakage in any fixture fittings.

d) Valves: Check that your property has different types of valves such as inlet valve on mains, drain valve at bottom of water storage tank, float valve in flush cistern, pressure reducing valve for water heaters, check valve to prevent backflow, etc. These valves control passage of water. All these valves are necessary for safe and sound passage of water and are also of prime importance when it is required to close the inlet supply during repair

e) Water Pressure: Water Pressure Gauge is used to check water pressure. Install water pressure gauge on the main line and check its pressure. It should be between 45 – 80 psi or 3.1 – 5.6 kg/cm2. Excess pressure will harm pipes, fixtures and appliances and lower pressure will causes inconvenience. In case of high-water pressure, a pressure reducing valve needs to be installed at mains.

f) Water Closets (WC): WC should be checked for the following:

Leakage: Run and check for leakages if any. Don't neglect minutest crack/leak if any, as it will grow with use and time.

Position: Toilets should be firmly fixed and sealed properly. They should not move in any case. Even check the base of toilet by applying body weight with your foot. It should not move.

g) Main Sewer Line & Traps: Main sewer line is a pipeline that carries the sewerage of your home to city sewer line or septic tank or cess pit. All household drains are connected to main sewer line. Run water from all taps and fixtures and check that no drainage line is blocked. Inspection of main sewer lines is done by running a video camera through the lines and identify following potential problems which are as follows -

1. Check for clogs if any
2. Material of sewer pipe line
3. Corrosion in sewer pipe line
4. Intrusion of tree roots
5. Connection joints

h) Traps: Traps are the part of drainage system that prevents the entry of foul smell, insects and vermin from the sewers. Check for nahni trap (aka floor trap) in bathroom, wash area, kitchen sink. Bottle trap for washbasin and kitchen sinks. P, Q and S trap in western water closet.

i) Water Heater: A water heater or a geyser has an average life span of 10 years but may vary depending upon water quality and maintenance. Water heater used for space heating along with heating water for fixtures and appliances, have lesser life span. Apart from life span of a water heater, it should be checked for following:

Location of water heater – It should be so located that any leakage in heater is noticeable and in case of any malfunctioning it should be easily accessible for repair works.

Size of water heater – It should meet the size of the home and the needs of the family.

Also, Scale buildup on the outside of water heater. and rust on the outside of water heater.

7.1.3 DWV in Plumbing

In plumbing, DWV stands for drainage, waste, and vent plumbing. These are the three types of systems that carry waste from home or allow air into pipes to facilitate the waste removal process. Having an airtight DWV system is critical for one's own safety and it's required by almost all city plumbing codes. That's because DWV pipes carry toxic gases such as methane, which could be poisonous if released through a leaky pipe. One can test your pipes by filling your DWV system with compressed air and monitoring the lines for signs of a leak.

1. Look all along the accessible portions of DWV pipes for the cleanout plugs. The plugs have square nuts in the middle for turning the plug.
2. Place a wrench over each of the square nuts and turn the plugs clockwise until tight to make sure the plugs are all sealed correctly.
3. Locate one clean-out plug where you want to conduct the pressure test. The plug should be somewhere your air compressor can easily access.
4. Remove the test plug by turning the square nut counter clockwise until the plug pulls free from the drain pipe.
5. Insert a test gauge into the hole on the pipe and turn it clockwise with the wrench until tight.
6. Turn on your air compressor and adjust the output settings to 5 psi.
7. Attach the hose on the compressor to the fitting on the test plug.
8. Allow the pipe to fill with air until the pressure gauge on the compressor reads 5 psi. Immediately shut off the compressor.
9. Turn the relief valve on the compressor until the gauge reads 4.6 psi, which is the standard pressure for testing DWV systems. Shut off the relief valve once this pressure is reached.
10. Allow the pipe to sit for about 10 minutes. During that time, watch the gauge to see whether the internal pressure in the pipe system dips below 4.6 psi. If it does, there is likely a leak in the line and a professional plumber should be consulted to identify the source of the leak immediately.

or has any mineral deposit.

7.1.4 Testing of Pipe Line

Testing of pipeline is necessary after installation. Different testing methods of pipe line are explained below:

a) Smoke Test

This test is done in case of leakage in C.I. Pipe.

I. Smoke is released from the bottom side of the pipe.

II. Smoke can be detected from the leaked portion, if any.

III. Smoke testing refers to physical tests made to closed systems of pipes to detect cracks or breaks.

IV. In plumbing a smoke test forces non-toxic, artificially created smoke through waste and drain pipes under a slight pressure to find leaks.

V. Plumes of smoke form where there are defects.

VI. This test can be performed when the plumbing is brand new, but more often it is used to find sewer gas leaks that may plague a building or an area.

VII. Any sign of smoke escaping can be considered a possible site for sewer gas to escape. Plumbing smoke tests are also used to find places where pipes will spill fluid, and to check sanitary sewer systems for places where ground water and storm runoff can enter.

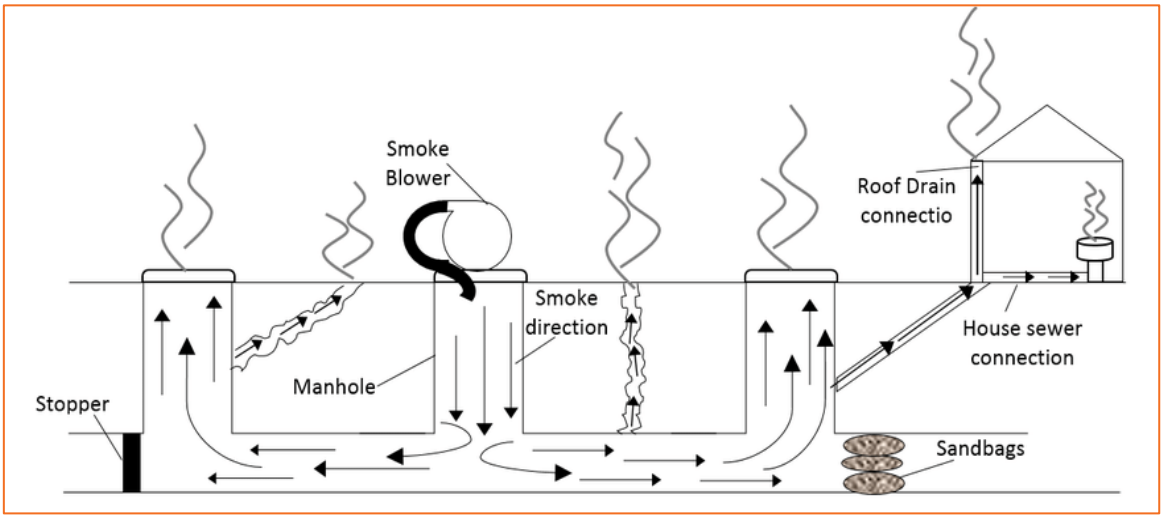

Fig 7.3 Smoke Test

Source : https://www.researchgate.net/figure/Smoke-Testing-process-for-finding-potential-sources-of-infiltration-and-inflow-into-a_fig2_325090081

b) Pressure Hydraulic Test

I. **Pressure Test:** Open the ball valve on the pressure tester and then connect a garden hose to the tester. (Fig. 3)

II. Turn hose on and allow the pressure in the pipes to reach 30psi. This usually takes several minutes.

III. When it reaches 30psi on the gauge, close the ball valve on the pressure tester assembly and then turn off the hose. You can now disconnect the hose from the pressure tester assembly.

IV. The pressure should stay at 30psi.

V. Leave at this pressure for several hours to make sure you do not have a small leak.

VI. If the gauge does begin to drop slowly, check the plumbing for leaking water

Fig 7.4 Pressure Test

Source : https://www.scsengineers.com/scs-advice-from-the-field-how-to-compensate-for-the-effect-of-the-ambient-temperature-variations-on-the-pressure-changes-within-the-pipe-during-hdpe-pipe-pressure-testing-using-incompressible-fluid/

7.1.5 Remedial and Preventive Measures for Common Plumbing Problems

Clogged drains and toilets, leaky faucets and pipes, problems with water heaters, poor water pressure, and a running toilet are the most typical plumbing concerns. Various solutions to each of these problems dicussed below.

1. **Clogged Drains and Toilets**

Causes: When something entirely or partially obstructs the drain, it becomes slow or clogged. Hair is frequently the problem in sinks and showers, but other objects, like a shampoo cap or a small toy, can get down the drain and clog the pipe. When something other than biodegradable waste uses a toilet and is flushed, it frequently causes issues. It is difficult or impossible for water to get through the obstruction and down the pipes because those heavy objects cannot pass through the pipe and remain there.

Remedial Action: Start by using a plunger to aid in unclogging the pipe. A plunger can be used on drains and toilets. The straightforward plumbing device uses air pressure to break off obstructions. Move the plunger up and down to create suction by placing the open end completely over the drain. Use tweezers or pliers to grab the clump and remove it from the drain if you can get the blockage near enough. If you are unable to remove the obstruction with a plunger, chemical drain cleaners are a choice. Plumbing snakes that can remove blockages and restore water flow are also available at home improvement stores.

2. **Leaky Faucets and Pipes**

Causes: A leaky faucet often results from damage to the washer that creates the seal on the tap. Tearing, dislodging, or stiffening are examples of damage. As a result of this damage, the washer no longer tightly seals, allowing a few drops of water to trickle from the faucet. The valve seat itself could rust or wear out over time. Your pipes' joints are where leaks are most prone to occur. Leaks may develop as a result of wear and tear, movement, high water pressure, or other types of damage.

Remedial Action: In faucets, the issue is resolved by swapping out the leaky washer. Although you can do this yourself, it's easier with specialised gear, so you might want to call a plumber. Pipe leak detection can be an easy or a difficult task. Even if you only need to replace a straightforward U-joint, it can be simpler to let a pro do the task to prevent a major problem.

3. **Water Heater Issues**

Causes: Sometimes leaks are the root of water heater issues, such as insufficient hot water. Water heater issues are also a result of mineral deposits. The deposits may lower the water heater's efficiency, which would decrease the amount of hot water available throughout your house. When sediment heats up and explodes or when scale builds up on heating elements, unusual noises can also come from your water heater.

Remedial Action: If the water heater is gas-powered, check the pilot light. The appliance won't create hot water if the pilot light isn't lit. Verify the temperature setting to make sure it wasn't mistakenly lowered. Drain the water tank to clear the silt if you believe mineral deposits, are the problem. Call a plumber if you notice water collecting on the floor because the tank is probably leaking and might need to be replaced.

4. **Low Water Pressure**

Causes: There are various reasons why water pressure may be low. If your neighbours also suddenly notice low water pressure, there may have been a water main break, which reduced the pressure at their taps. If a pipe inside your house leaks, the pressure will decrease in the same way. To check for leaks, turn off all of the faucets, look at your water metre, and wait a few hours without using any water. You most likely have a leak if your water metre changes. Mineral and sediment buildup in the pipes, faucet aerators, and showerheads are further potential causes. Due to the buildup, the water flow is slowed and low pressure is the outcome.

Remedial Action: Start with the aerators or showerheads where you have low water pressure if you believe build-up is the culprit. To clean the faucet tap end, unscrew it. To remove the buildup, soak the aerator in vinegar for a whole night. If the aerator or showerhead can't be removed, put vinegar in a plastic bag. To get the aerator or showerhead to sit in the solution, tie the bag around the faucet. To fix other problems and restore water pressure, a plumber is frequently required.

5. **Running Toilet**

Causes: When the toilet's internal mechanisms stop functioning properly, this frequently results in a toilet that runs continuously. If the flapper valve no longer fits properly, water might frequently flow through it. A leak, a loose fill tube, and an unbalanced float are further potential culprits. Use food colouring to check the tank for leaks. Check the bowl after about 20 minutes to see whether there was a leak that allowed the colour to get into the water.

Remedial Action: Check each component to identify the precise issue. Check that the fill tube, a small, flexible tube inside the tank, is still attached and pointed in the direction of the overflow tube. To guarantee that the fill valve shuts off properly, adjust the float. To verify the chain is the right

length and is not tangled, check it on the flapper. All of the internal tank components may need to be replaced if straightforward changes are unsuccessful. Toilet repair kits are commonly available in home improvement stores and fit conventional models.

For increasing the life of plumbing systems, the system must be proper maintenance and repairs which save the money also. One example, if one water faucet which is leak single drop of per second that waste about 2,300 gallons water per year. Some addition remedial and preventive measures are described below:

1. Water Breaks:

The piping of water distribution system will need one time or another repair on a break or leak form in the line. The following are problems we may have during a waterline break:

- The water supply for fire protection is reduced or does not exist.
- Ignoring of under pressure of water that harm the structures,
- foundations, damages and also in landscaping or will causes a serious
- erosion problem.
- The distribution system may be contaminated by external sources, if pipe is broken that cause a health harm issue.
- For industrial and normal domestic use, the water supply can be completely cut off.

To ensure proper repair of a water break, keep red line prints and as built drawings on hand that show the water distribution system, existing conditions, and locations. You must ensure that, when you make a repairs or line change of your set of print every time, you should remove from the red line. And it will modify by the master set of base prints. For subsurface survey and pipe location work, electronic devices are available. Therefore, you have to find the interconnection point, coating or exterior surface condition. For future use, make notes on the maintenance prints to show the general condition of the system. To show the approximate age of the installation or its parts, use a symbol. Main thing is that your print should be up-to-date and complete. This help in planning maintenance and repairs.

Many times, they offer clues to the most probable location and probable cause of trouble. Now and then, the system should be flushed through hydrants and blow-offs to remove scale and accumulation in pipes and fittings. Each point should be flushed until the water comes out reasonably clear. All valves should be in their normal operating positions before you go on to the next point. Flushing dead ends are vital.

When flushing does not induce enough velocity to scour the mains clean, night flush them with a large discharge. Night operation lessens work disruption caused by water shutoff or decreased water pressure.

2. Water Mains

Since water main breaks must be repaired as fast as possible, personnel must be trained and repair plans made in advance. The following procedures are essential:

1. Post the telephone numbers of the fire department and key personnel and have alternate personnel available in case members of the regular repair crew cannot be reached at the time of a break. Notify the public works officer at the time the break is reported.

2. Always keep the following items readily available: valve keys, hand tools, digging tools, pavement breakers, trench shoring, a portable centrifugal or diaphragm pump, floodlights, an emergency chlorinator, and calcium hypochlorite powder.

3. Maintain enough pipe repair materials and supplies. As a temporary measure, wooden plugs can be used to stop small holes in a main. These plugs can be replaced later with metal plugs, or repairs may be made by other means. Wooden plugs can also be used temporarily to plug the ends of a pipe up to 8 inches in diameter, but such plugs must be braced to withstand existing main pressure. After repairs are completed, the main must be disinfected.

3. Thawing Frozen Pipes

In cold weather, a water-supply system can freeze. Because of the lack of protection against freezing and sometimes regardless of it, pipes frequently freeze in temperate zones. When this happens, the pipes must be thawed. Breaks must be found, if possible, before natural thawing to prevent damage to material and property. Alert personnel to watch for the signs of a broken line. The prevention of freezing pipes can sometimes be accomplished by using heat tapes and cables. Before starting to thaw a frozen pipe, open faucets affected by the freeze. Frozen pipes can be thawed by applying heat at the lowest open end of the frozen section. (Do NOT start in the middle of a frozen section because a pocket of steam could develop and an explosion or damage to the pipe can occur.) Where there is no danger of fire, simply heat the pipe with a blowtorch, applying the flame on the outside of the pipe. Using hot water is the preferred method for thawing frozen water pipes or heating pipes inside of buildings. Do NOT use an open flame. A safe method is to wrap the frozen section of pipe with cloth and pour hot water on it until the ice gives way. Remember to protect the floor by catching the water in buckets or by covering the floor with material to absorb the water.

A good method of thawing water pipes that are underground or otherwise hard to get to is shown in Fig. 4, when using this method, remove the fittings (see illustration) and insert one end of the small pipe or tube into the frozen pipe. Now add an elbow and a piece of vertical pipe to the outer end of the thaw pipe. Place a bucket under the opening to the frozen pipe and insert a funnel in the open end of the vertical pipe. With that done, start pouring boiling water through the funnel into the pipe. As the ice melts, push the thawed pipe forward.

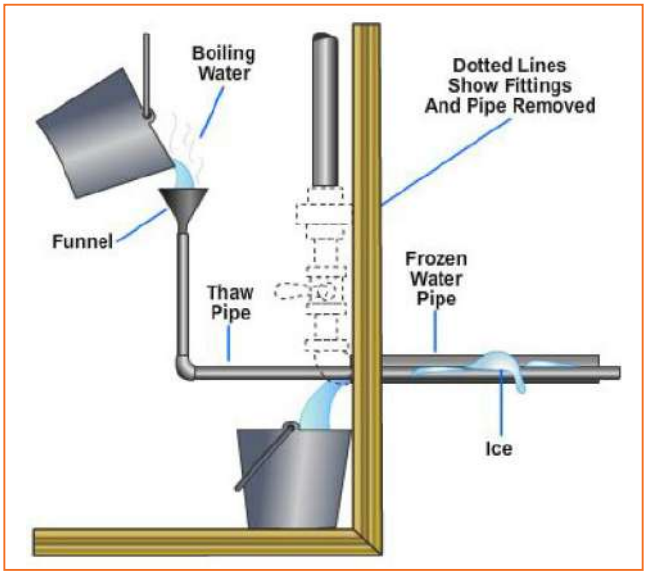

Fig 7.4 Pressure Test

Source : https://www.waybuilder.net/free-ed/skilledtrades/Plumbing/06PlumbFixtures/06PlumbFixtFra.asp

I. Electrical Thawing

Electrical thawing of frozen service lines is quick and cheap. The electrical current for the thawing operation consists of a source of current (a DC generator, such as a welding outfit, or a transformer connected to an AC outlet) and two insulated wires connecting the current source and the pipe.

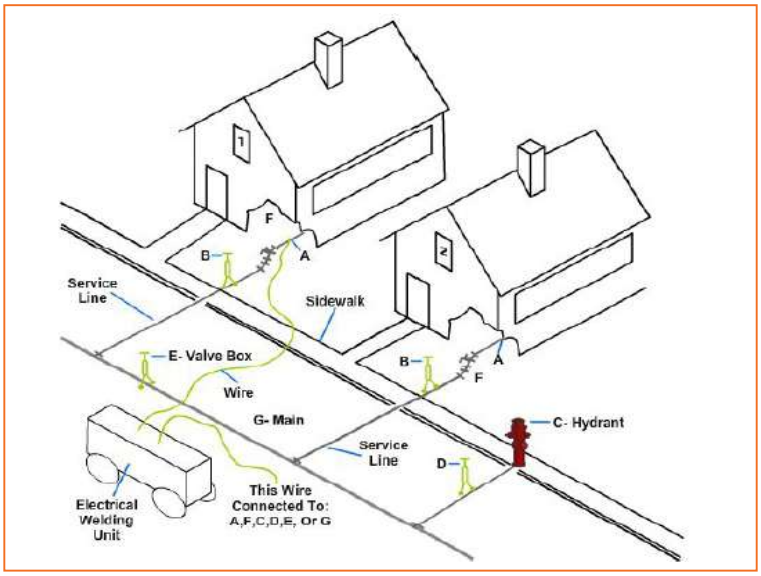

Fig. 7.6 Connection points for thawing frozen service lines

Source : https://www.waybuilder.net/free-ed/skilledtrades/Plumbing/06PlumbFixtures/06PlumbFixtFra.asp

Only qualified personnel should use power lines as a source of current. As current flows through the pipe, heat is generated, and the ice within the pipe begins to melt. As the water starts to flow, the rest of the ice is melted by contact with the flowing water. The wires from the current source may be connected to nearby hydrants, valves, or exposed points at the ends of the frozen sections.

Some data on current and voltage required for electrical thawing of various sizes of wrought iron and cast-iron pipes are presented in Table shown below:

Type of pipe	Pipe Size (in.)	Pipe Length (ft.)	Approximate	Approximate (amps)
Wrought Iron	3/4	600	60	250
	1	600	60	300
	1	600	60	350
	1/2	500	55	400
	2	400	40	450
	3	400	50	500
Cast Iron	4	400	50	600
	6	300	40	600
	8			

Table 7.1 Relation of current and voltage required for thawing

The time for electrical thawing may vary from 5 minutes to over 2 hours, depending on pipe size and length, intensity of freezing, and other factors. The best practice is to apply current until the water flows freely. Use the following procedures in electrical thawing:

1. DC Generator : To thaw pipes with a welding generator or similar DC source, set the generator to the correct amperage for the pipe to be thawed and connect the leads to the pipe.
2. AC Circuit: Transformers are required to adjust amperage of an AC circuit to the pipe being thawed. To reduce hazards, have a competent Construction Electrician (CE) set and connect transformers, make the connections, and assist in the thawing process. Where frequent thawing is necessary at different points, the transformers may be mounted on a trailer for ready use.

Some precautions in electrical thawing are given below:

- Avoid a higher current than listed in table above shown. When in doubt, use low current for a longer period.
- Select contact points on the pipe as close as possible to the frozen section.
- Assure that contact points are free of rust, grease, or scale.
- Remove meters, electrical ground connections, and couplings to buildings with plumbing in the pipeline to be thawed.
- If there are gaskets or other insulation at pipe joints, thaw the pipe in sections between such joints, or use copper jumpers to close the circuit across insulated points.

II. Steam Thawing

Steam thawing of frozen systems is slower than electrical thawing and should be used only when insulating materials in pipes (plastic, transits, and wood), pipe joints, or couplings make the use of electricity impractical. In steam thawing, a hose connected to a boiler is inserted through a disconnected fitting and gradually advanced as the steam melts the ice.

Variation of Water Pressure

A change of water pressure can cause much discomfort to persons using the plumbing system. The mixture of hot and cold water from a shower can suddenly vary in temperature or rate of flow when water is turned on at another outlet. Failure to remedy this condition could injure somebody, especially if the temperature is scalding.

When a switch in pressure and water flow occurs often, look at the water pipes. Check the pipes to see if they are the proper size in diameter for their length and height as originally installed. Also, look for liming and corrosion inside the pipes. Enough liming and corrosion can reduce the diameter of the pipe, causing restrictions that lead to low pressure and slow water flow. Sometimes the trouble occurs after more fixtures have been installed in the system. When this happens, the piping is probably overloaded because of the extra fixtures. Pressure and water flow may also change when there is too much friction in the pipe, too many fittings, or changes in the direction of the piping. If the pressure in showers changes only when other outlets are open, you can usually correct the trouble by installing automatic mixing valves. The only answer to an increase in the water flow from pipes that are too small is to replace them with larger pipes.

Pipe Leaks

When a leak develops at a threaded joint of pipe, one of the most likely suspects is a fractured or ruptured pipe. Fractures often occur at the end of a length of pipe because of strain imposed by vibration of water hammer.

It occurs at the end of the pipe because the wall thickness is decreased and weakened by threading. The risk of fracture becomes even greater when the threads are not cut true. In cold climates, freezing sometimes causes pipes to rupture, in which case replacement becomes necessary. A loose or cracked fitting can also cause leakage at the threaded joint of a pipe. These and other common failures resulting in pipe leakage make it important for you to determine the exact location and cause of failure before beginning any repairs to the piping.

Locating Leaks

Find and repair leaks in the water piping system as quickly as possible to prevent serious damage to footings, walls, floors, plaster, and other parts of the structure, and to conserve water. Also, sanitation and hygiene issues are associated with water leaks, such as mould, insect's sanitary system and disease. Find leaks systematically by inspecting exposed piping and valves and by examining walls, floors, and ceilings around concealed piping. You should also check gauges, meters, and other water flow recording devices for evidence of abnormal flow, which might reveal loss through leakage.

In galvanized pipe installations, where the fittings on either side of the leak are not readily available, the leaking section may be cut out. In this operation, one person holds the pipe with a backup wrench to keep it from being over tightened or loosened in the adjacent fittings, and another person cuts a thread on it while it is in place using a hand type of pipe threaded. The cut-out section is then replaced with a coupling, a pipe section of the required length, and a union.

When a piece of cast iron pipe less than full length is needed for replacement, cut it from a double-hub pipe, so the remaining piece has a hub left for use in other work. If you need a fitting for a short space or if existing work cannot be removed easily, use short spigot ends for sleeves. Closely observe figure shown below. This figure shows how to install a fitting in a restricted space.

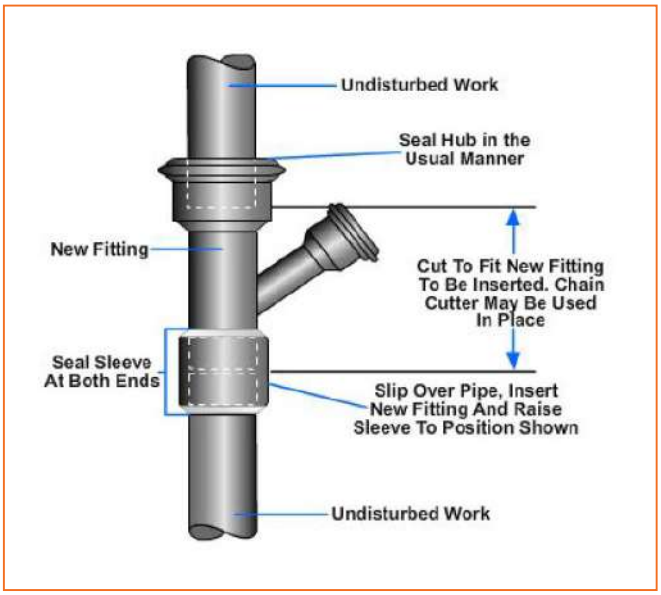

Fig. 7.7 Installing a fitting in restricted space

Source : https://www.waybuilder.net/free-ed/skilledtrades/Plumbing/06PlumbFixtures/06PlumbFixtFra.asp

When the job calls for adding connections to an outside vitrified clay sewer line, here is one systematic method, shown in below figure.

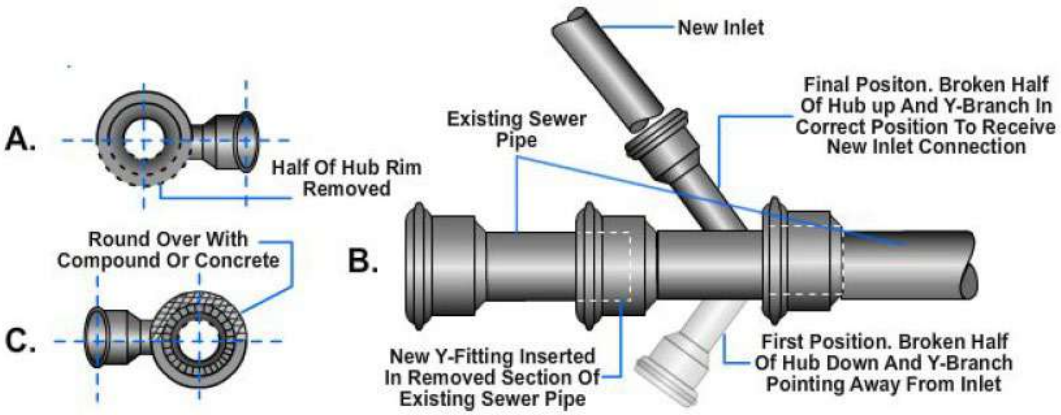

Fig. 7.8 Adding connection to an outside vitrified clay sewer pipe

Source : https://www.waybuilder.net/free-ed/skilledtrades/Plumbing/06PlumbFixtures/06PlumbFixtFra.asp

1. Remove a section of the existing sewer pipe that is long enough to receive a new Y-fitting.
2. Break half of the hub rim of the new Y-fitting
3. Insert the spigot end of the Y-fitting into the hub of the existing pipe. At the same time, place the remaining half of the hub end of the Y-fitting over the cut end of the existing pipe with the Y-branch pointing away from the new inlet.
4. Rotate the Y-fitting, so the broken half of the hub is up and the Y-branch is in the correct position to receive the new inlet connection.
5. Pour the joint carefully; round over the broken half of the hub with plenty of concrete or mastic compound.

Emergency Temporary Repairs

At times, a pipe may start leaking and the materials needed to repair it permanently are not on hand. Here, you may have to use a temporary or emergency repair. Keep in mind that a permanent repair should always be made when the proper tools or materials are available.

One simple method of making a temporary repair of a leaky pipe is to use a length of rubber hose. After turning off the water supply, remove the defective section of the pipe by cutting it with a hacksaw. Then take a piece of rubber hose, slightly longer than the section of pipe you removed, and slip it over the ends where the cut was made shown in figure below. Ensure the inside diameter of the hose matches the outside diameter of the pipe. Use hose clamps to hold the hose securely in place.

Another temporary method of repair for a leaky pipe is to wrap the leaky area with sheet rubber, and then place two sheet metal clamps, one on each side of the pipe, on the sheet rubber covering, as Fasten the clamps with bolts and nuts. Sheet metal clamps for this type of repair can be made from scrap material from the sheet metal shop. One may want to make up a few of these clamps to keep on hand for an emergency repair job.

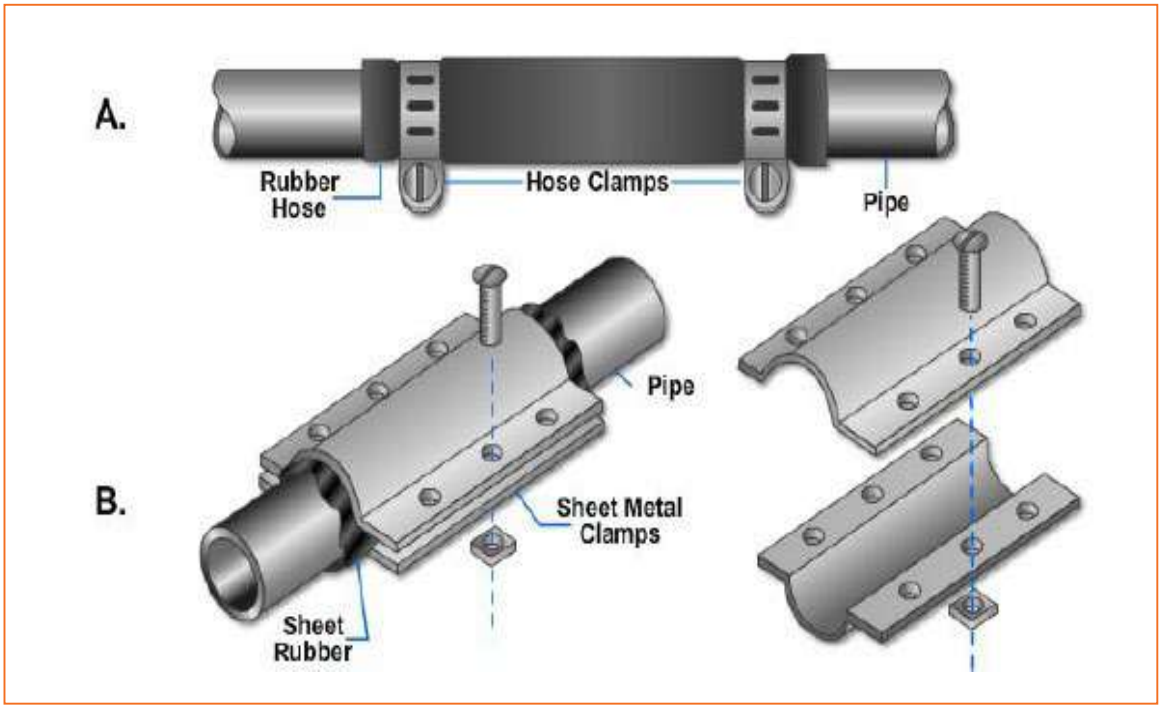

Fig. 7.9 Temporary type of repairs for leaky pipes

Source : https://www.waybuilder.net/free-ed/skilledtrades/Plumbing/06PlumbFixtures/06PlumbFixtFra.asp

Water Tank Failures

Where a plumbing system has been in use for some time, two failures in water tanks are

(1) leaky seams and

(2) corroded areas requiring welded patch plates.

To repair a defective seam, first drain the water tank dry. Then clean the surfaces to be repaired. By welding or brazing, you can then make the leaky portions watertight.

As an effective tank patch for a large hole, you need both a temporary and a permanent patch. One temporary patch is a tapered softwood plug. Insert the plug in the hole, and tap it lightly with a hammer until the seal is watertight. Then saw off the top of the plug so it is flush with the tank wall.

Next, clean the area around the plug to be covered by the permanent patch by wire brushing. Drain the tank; now you are ready to apply the permanent patch. One type of permanent patch includes a rubber gasket and a metal plate. Rubber sheeting, at least 6 inches by 6 inches and l/16-inch-thick, may be used for the gasket, and it should be centered on the plug and cemented with adhesive. The patch plate of black steel or nonferrous (no iron) metal should be of the same material and thickness as the tank wall but a lot larger than the hole. Cover the hole with the metal plate, keeping an equal overlap around the edges, and braze or weld the plate to the tank, using a continuous seam.

Water Closets

Moisture on the floor at the base of a water closet bowl usually means the seal or gasket between the closet and its outlet has failed; however, it can result from condensation on the tank or piping or from leakage of the tank, flush valve, or piping. When the seal leaks, remove the water closet bowl and install a new seal to prevent damage to the building. This also prevents entry of sewer gas into the room.

In servicing plumbing fixtures, you have the job of clearing stoppages in water closets. Information on tools and chemicals used in clearing stoppages in water closets and other fixtures is given later in this chapter.

Flush Tank

Knowing the principles of operation of a flush tank will enable you to find the source of trouble when a flush-type water closet tank is not operating properly. Fig,8 shows the parts of a flush tank, though in different types of flush tanks you may find some changes in the method of operation.

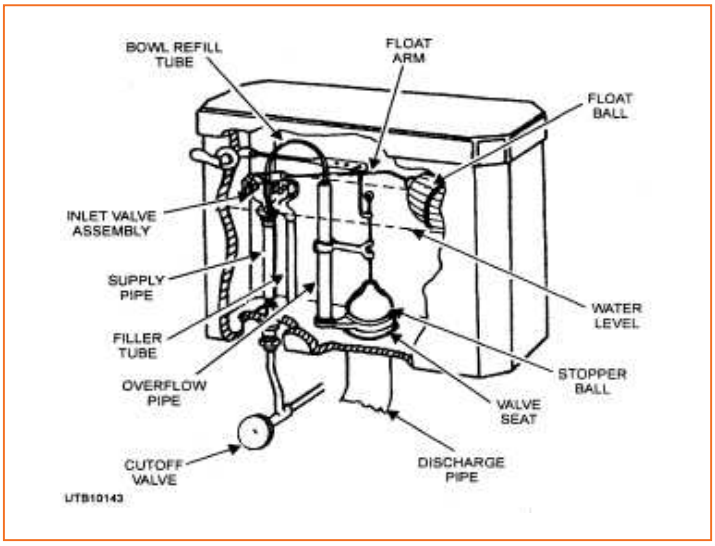

Fig. 7.10 Components of water closet flush tank

Source : https://constructionmanuals.tpub.com/14265/css/Water-Closets-180.htm

Simple though it may seem, you must understand the operation in order to troubleshoot an inoperative flush tank.

Stage 1: When the flush handle is pushed downward, the rubber stopper ball or flap valve is raised from the valve seat to allow the water from the tank to go into the discharge pipe.

Stage 2: As the water lowers in the tank, the ball or flap lowers and the movement of the float arm opens the inlet valve, allowing water to start flowing into the tank slowly.

Stage 3: As the water flows from the tank to the discharge pipe, the ball or flap seats and incoming water holds the ball or flap in place and the tank fills.

Stage 4: As the water continues to fill the allow the valve to close. In this case, bend the float arm downward a bit to push the valve tighter into its seat.

To replace the washer on the bottom of the plunger, start by shutting off the water

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Stage 4: As the water continues to fill the allow the valve to close. In this case, bend the float arm downward a bit to push the valve tighter into its seat. To replace the washer on the bottom of the plunger, start by shutting off the water Then unscrew the two thumbscrews that pivot the float rod lever and the plunger lever. Push the two levers to the left, drawing the plunger lever through the head of the plunger. Lift out the plunger, unscrew the cap on the bottom, insert the new washer, and reassemble the parts. If the cap is badly corroded, replace it with a new one. When replacing the washer, examine the seat for nicks and grit. The seat may need regrinding. Then unscrew the two thumbscrews that pivot the float rod lever and the plunger lever Push the two levers to the left, drawing the plunger lever through the head of the plunger. Lift out the plunger, unscrew the cap on the bottom, insert the new washer, and reassemble the parts. If the cap is badly corroded, replace it with a new one. When replacing the washer, examine the seat for nicks and grit. The seat may need regrinding. If water continues to run into the

If water continues to run into the closet bowl after flushing, yet the tank does not refill, some part of the flush valve assembly is at fault because the flush valve is not closing properly. To locate the trouble and get the tank back in order, proceed as follows.

- First, stop the inflow to the tank by holding up the float ball or supporting it with a stick. Then drain the tank by raising the rubber stopper ball or the flapper.
- Examine the stopper ball to see if it is worn or out of shape, or has lost its elasticity. If so, unscrew the lower lift wire from the ball and replace the ball with a new one; if it is a flapper valve, remove the flapper and replace it
- Ensure the lift wire is easily fitted over the centre of the valve by means of the adjustable guide holder. By loosening the thumbscrew, you can raise, lower, or locate the holder over the overflow tube. The horizontal position of the guide is fixed exactly over the centre of the valve by loosening the locknut and turning the guide screw.
- The upper lift wire should loop into the lever armhole directly above the center of the valve. The tank should empty within 10 seconds. Because of lengthening of the upper lift wire and insufficient rise from its seat, emptying the tank may be longer than 10 seconds and the flush weak. In this case, shorten the loop in the upper lift wire. Also, a drop or two of lubricating oil on the lever mechanism makes it work more smoothly.

If you have a water closet tank that sweats and drops water on the deck, check the temperature of the water in the tank. If the temperature is very cold, this is the problem. The moisture in the air surrounding the tank is condensing on the tank. Solutions to the problem are placing a terry cloth on the tank to catch the water, placing a Styrofoam insert in the tank, or installing a water tempering valve, which places some warm water in the tank while the tank is filling.

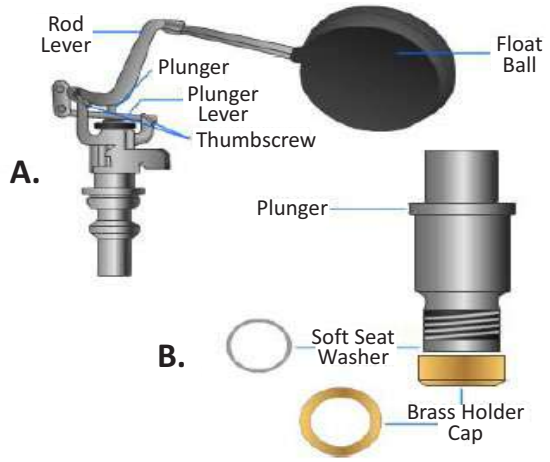

Fig. 7.11 A: Ball cock, B: Plunger wash and cap

Source : https://www.waybuilder.net/free-ed/skilledtrades/Plumbing/06PlumbFixtures/06PlumbFixtFra.asp

Flushometers

Two major problems with flush valves are that the valve runs continuously, instead of shutting off at the right time, or that it fails to deliver the desired amount of water (short flushing). Since flush valves are installed to avoid waste, they must be properly maintained. Once you understand the operation of a valve, you can keep a flushometer in good repair.

The below figure shows the components of a diaphragm-type flushometer.

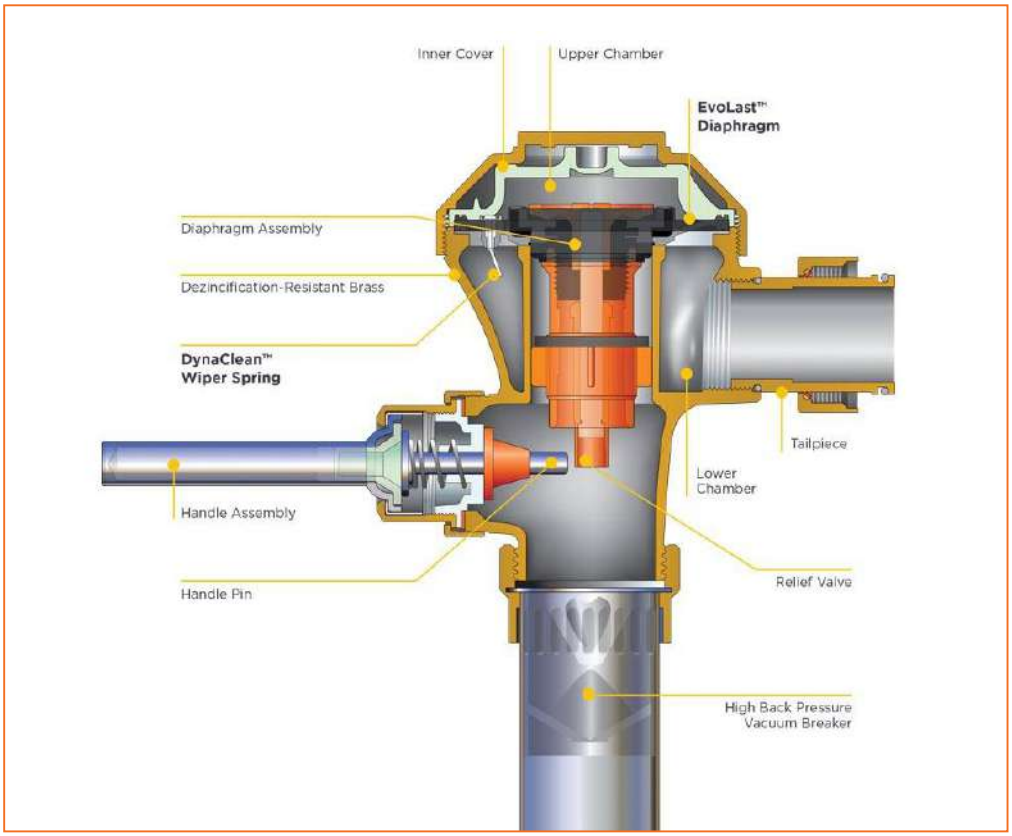

Fig 7.12 Components of a diaphragm-type flushometer

Source : https://www.americanstandard-us.com/ultima-diaphragm-flush-valves

Stage 1: The diaphragm valve is in the ready position. In this position, the upper and lower chambers contain the same amount of pressure. Therefore, the diaphragm remains seated on the seat.

Stage 2: When the handle is moved in any direction, the plunger opens the relief valve, which allows the water from the upper chamber to flow into the lower chamber and causes the diaphragm to rise off its seat. Water now continues to flow down the barrel and into the fixture.

Stage 3: As the valve lifts the diaphragm, water begins to flow slowly through the bypass orifice until the pressure raises enough to equalize the pressure in the upper and lower chambers, seating the valve.

Operation of a Piston Type Flushometer

The piston-type flushometer valve, shown in fig is opened by a lever, which discharges the water from the dashpot chamber. The reduced water pressure in the dashpot chamber then forces the piston assembly upward, which allows the water to enter the fixture. The closing of the valve is automatically controlled with a bypass through which the water enters the dashpot chamber. This forces the piston

Operation of a Piston Type Flushometer

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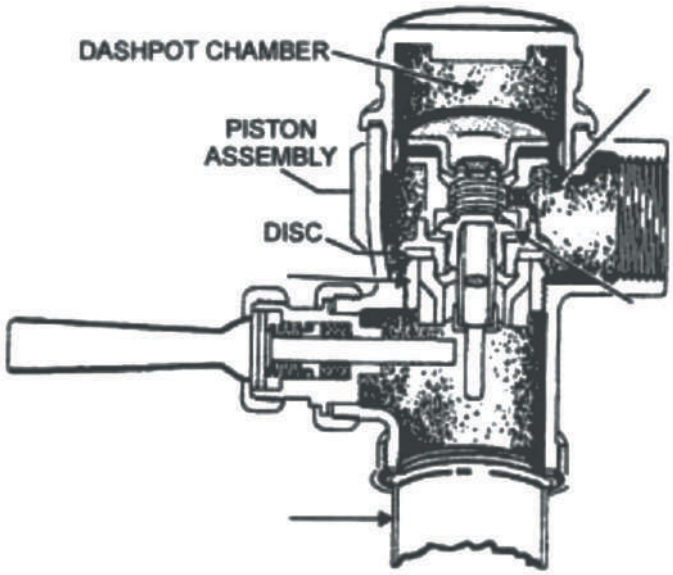

Fig 7.13 Piston Type Flushometer

Source : https://constructionmanuals.tpub.com/14265/css/Repairs-184.htm

Repairs:

Flush valves give years of adequate and trouble-free operation when they are properly installed and maintained.

Continuous flow of water through a piston type of flush valve is usually caused by failure of the relief valve to seat properly or by corrosion of the bypass valve. In both cases, there is not enough force on the piston to force it to seat. If the relief valve fails to seat as it should, the leakage may be enough to prevent the upper chamber of the valve from filling, and the piston remains in the open position.

Inspect the relief valve seat for dirt or other foreign substances that may be causing the relief valve to tilt; disassemble the piston, wash the parts thoroughly, and reassemble. Replace washers that are worn, making sure that the surface upon which the washer sets is perfectly clean; scrape off old rubber if any sticks to the metal surface.

Corrosion of the bypass valve in the centre of the top plate also causes continuous flow; the water cannot pass into the upper chamber of the valve, and no force is exerted on the piston to move it downward to its seat. Very dirty water passing through the system can clog the bypass and deprive the upper chamber of water. When pipelines in a new installation are not thoroughly flushed before they are placed in operation, the pipe dope or dirt in them can stop up the bypass valve.

Likewise, in a diaphragm valve, if chips or dirt carried by the water lodge between the relief valve and the valve seat, the relief valve cannot seat securely. The water leakage prevents the upper chamber of the valve from filling with water. The valve then remains in the open position since there is no pressure to force the diaphragm to its seat.

Likewise, in a diaphragm valve, if chips or dirt carried by the water lodge between the relief valve and the valve seat, the relief valve cannot seat securely. The water leakage prevents the upper chamber of the valve from filling with water. The valve then remains in the open position since there is no pressure to force the diaphragm to its seat.

Short flushing can occur in a diaphragm type of valve. If the valve seat, diaphragm, and guide cover have not been tightly assembled, you should reassemble the valve to ensure proper operation. Sometimes you may find the bypass tube has been tampered with, enlarging it so the water passes rapidly into the upper chamber and closes the valve before the desired volume is delivered.

Avoid getting oil or grease on the valve parts, which can lead to swelling of the rubber parts causing them to become unserviceable.

Another commonly used unit is the pressure valve-head flushometer.The most common problem with this type of flushometer is the rubber cap. To replace the rubber cap is a simple task; remove the retaining screws, lift out the plate, and remove and replace the cap.

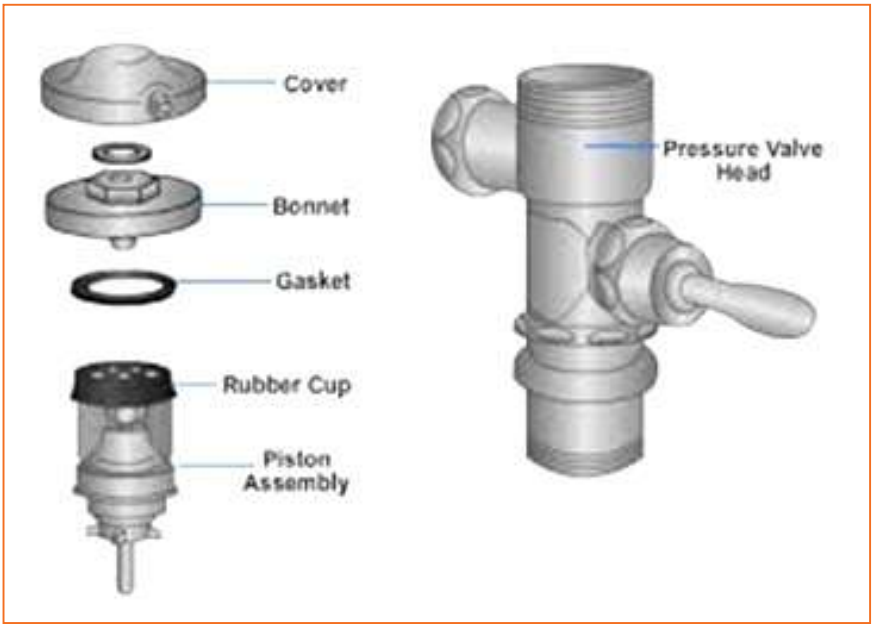

Fig 7.14 Pressure valve head flushometer

Source : https://www.waybuilder.net/free-ed/skilledtrades/Plumbing/06PlumbFixtures/06PlumbFixtFra.asp

Notes

Faucets:

Different types of faucets are used in plumbing installations. If you can repair the compression washer faucet, you should have no trouble in repairing other types of faucets. A cutaway view of a compression faucet is shown in Fig.This faucet, with a dishwasher and a solid or removable seat, requires frequent attention to maintain tight closure against water pressure. When a faucet is turned off, the washer on the end of the stem rubs against the seat. Frequent use wears down the washer and eventually causes the faucet to drip. A small, steady leak in a faucet wastes water. The remedy for a dripping faucet is simply to replace the washer. Be sure to replace flat or beveled washers with washers of the same design.

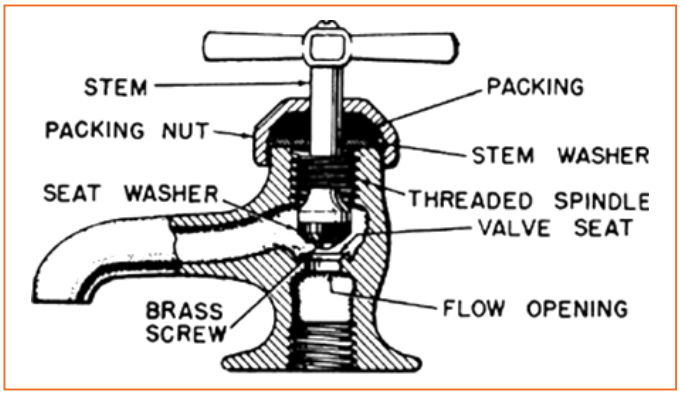

Fig 7.15 Compression faucet
Source : https://encyclopedia2.thefreedictionary.com/compression+faucet

Standard Faucets

- To repair a standard washer faucet, follow these steps
- Shut off the water supply to the faucet and open the faucet all the way.
- Remove the faucet handle, bonnet, and stem.
- Remove the brass screw holding the washer to the bottom of the spindle. Replace the washer with a new one which is flat on one side and slightly rounded on the other so it can get both horizontal and vertical pressure and provide a firm seat. Use a good quality hard-composition washer because leather or soft washers do not give long service, particularly in hot water lines. If the brass screw is in poor condition, replace it with a new one
- Examine the valve seat and repair or replace it with a new one if necessary, before replacing the spindle; otherwise, a new washer provides adequate service for only a short time.
- Reface or ream solid seats (with a standard reseating tool consisting of a cutter, stem, and handle. Rotate the tool with the cutter centred and held firmly on the worn or scored seat. Take care to prevent excessive reaming. Remove all grinding residue before reassembly. A solid seat can be replaced with a renewable seat by tapping a standard thread into the old solid seat and inserting a renewable seat.
- Remove renewable seats with a regular seat-removing tool or Allen wrench. When the seat is frozen to the body, apply penetrating oil to loosen it. Faucet seats can usually be tapped, reseated, or replaced without removing the faucet from its fixture.
- To stop leakage at the bonnet, replace the stem packing and the bib gasket.

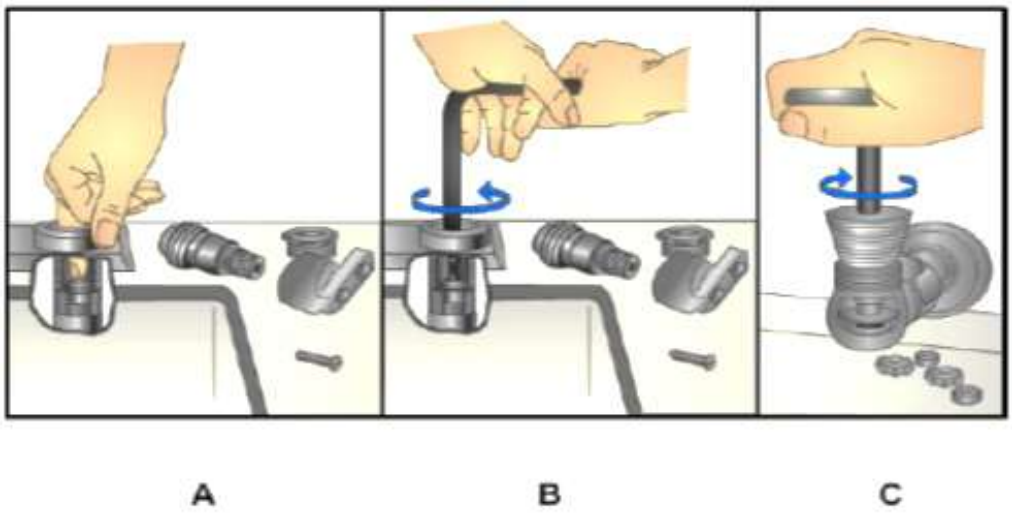

Fig.7.16: A: Inspecting, B:Removing, C:Refacing Faucets seats

Source : https://www.waybuilder.net/free-ed/skilledtrades/Plumbing/06PlumbFixtures/06PlumbFixtFra.asp

Occasionally, it may be found ball-bearing washer holders installed in faucets at some activities. The ball bearings between the stem and washer holder permit movement of the "washer" free of the movement of the stem. This allows the washer to stop its rotation on the slightest contact with the seat, thereby reducing the frictional wear of the washer.

Shower Heads

Showerheads that supply an uneven or distorted stream can usually be repaired by removing the perforated faceplate and cleaning the mineral deposits from the back of the plate with fine sandpaper or steel wool. You can open clogged holes with a coarse needle or compressed air.

7.1.6 Correct Practices for Troubleshooting and Maintenance

Preventative Plumbing Maintenance Tips:

Following are some points to be kept in check for proper maintenance of the pipe:

1. Create a Preventative Maintenance Schedule.
2. Fix Leaking Faucets and Showerheads.
3. Check Appliances for Water Leaks.
4. Keep Your Drains Clear.
5. Watch What You Flush Down the Toilet.
6. Inspect Your Sewer Drains.
7. Check Your Water Pressure.
8. Shut Off Outdoor Fixtures with the Seasons.

Routine Maintenance

Following are some point for routine maintenance of the plumbing system:

- Give your pipes a good cleaning once a month. Hair, grease, and other gunk build up in drains over time.
- Fix recurring problems.
- Block debris from entering pipes.
- Flush your drains regularly.
- Don't dump grease down the drain.
- Give your garbage disposal a rest.
- Don't throw things down the toilet.

Some other point regarding maintenance are as follows:

1. Fix leaking faucets and showerheads: Dripping faucets can waste a lot of water and that can add to your bill. And if you don't fix a dripping faucet or showerhead, the drip can get worse over time. Those problems can cause water damage. To prevent problems, check your facets regularly for leaks and make repairs as needed. Check the handles to make sure no water drips when the handles are turned to the off position and check underneath the sinks for water stains or drips when the water is running.
2. Unclog slow drains: When the water is slow to drain there may be a problem. Before it gets out of hand, use a homemade mixture of vinegar and hot water to flush down the drain and unclog any debris. This preventative maintenance tip can be done every few months and will get the drain flowing again.
3. Check all exposed pipes and appliances for water leaks. Your disposal, refrigerator, or water heater can be the source of a leak. Look at any manufacturer's requirements for maintaining your appliances. Watch for visible signs of a leak such as water stains on walls and ceilings, or puddles of water. Also, be wary of mildew. Installing a drip tray underneath your water heater and washing machine can help limit the damage if a leak were to occur.
4. Fix leaking toilets: Sometimes a faulty seal around the valve seat can cause your toilet to run even when it is not flushed. Over time, gunk will form around the valve seat and flapper. This gunk will prevent the flapper to seal properly, which will cause the water to continue to run. Another problem could be with the handle or tank stopper. The repair that is needed is often quick and inexpensive maintenance.

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5. Be careful what you flush or pour down the drain. The problem with drains and toilets is that so many things can get flushed down them. The easiest way to prevent problems with your pipes is to be careful what you flush or pour down them, to begin with. Don't flush anything other than toilet paper and human waste down the toilet. Don't pour anything that can be reactive down the drain.
6. **Check the water pressure:** Water pressure is how much force is coming out of your faucets and showerheads. You can test the water pressure on your system with a pressure gauge to make sure it is at a safe level. One other preventative measure is to add a pressure regulator to maintain your water pressure at a safe level.
7. Remove and clean your shower head of any sediment that may have accumulated. This can improve the water pressure of your showerhead.
8. Drain your water heater to remove sediment annually to semi-annually. Over time your water heater can get sediment in it and become less effective.
9. Look inside the burner chamber of your water heater. You shouldn't see any flakes of rust inside of the chamber. And verify the flame of the water heater is a blue color with no signs of yellow in the flame. If you see a yellow color, this may mean that the jets need to be cleaned.

Performing preventative maintenance for your plumbing can help you avoid a major plumbing problem. Sometimes you may need a repair after checking items to keep them maintained. Although some repairs can be do-it-yourself, others may require more expertise

7.1.7 Application of Mechanical and Hydraulic Principles for Clearing Blockages

Cleaning of sewers blocks

Sewer cleaning methods depend on the characteristics of the wastewater being conveyed, fluctuations in wastewater flows, alignment or grade of the sewer, pipe material, size, and structural condition of the sewer.

Stoppages can be cleared or prevented, and sewers cleaned by either hydraulic or mechanical methods. Traps should be placed in manholes downstream from the sewer cleaning operation to catch debris loosened during cleaning. Debris removed from the sewer should be observed for content. The type of debris removed will give a good indication of what types of defects may exist in the sewer and the severity of these defects. The debris removed should be disposed of in an approved location. There are various methods for cleaning the blocks like hydraulic cleaning, mechanical cleaning, chemical cleaning etc.

We are here discussing hydraulic and mechanical methods only.

Hydraulic Cleaning Methods

Hydraulic cleaning methods such as jet cleaners, jet rodders, and high velocity cleaners consist of cleaning a sewer with a high-pressure water jet. This jet produces water velocities which are usually high enough to wash most grit, grease, and debris down the sewer and leave the pipe clean.

Balls, kites, bags, pigs, tires and scooters are all examples of hydraulic cleaning equipment. These devices fit into a sewer and partially block the flow. Water builds up behind the device and creates pressure. This pressure forces water at a high velocity around the outside edge of the cleaning device. This high-water velocity cleans the walls of the sewer and pushes the material and debris downstream where it can be removed at a manhole.

Sewers can also be cleaned or kept clean by flushing. Flushing is most effective with a sudden rush of deep water down the sewer. It is important that dept and velocity are used together because the use of either depth or velocity alone will be ineffective. Devices are available that provide automatic and frequent flushing. Otherwise, hand flushing may be done at specified intervals. The devices commonly used in flushing operations include automatic flush tanks, flushing manholes, a fire hose, a connection to a water main with an air gap device, a temporary fixed dam, and a moving dam.

Fig.7.17 Sewer Cleaning Jetting Machine

Mechanical Cleaning Methods

Mechanical cleaning methods consist of using equipment that scrapes, cuts, pulls, or pushes debris out of the pipe. Mechanical cleaning equipment consists of bucket machines, power rodders, and hand rods. A bucket machine operation includes a special bucket-type device that is pulled through a sewer. This device removes debris as it is pulled through the pipe. Rodding can be done by power or hand. It entails pushing or pulling a steel rod or snake through a sewer with special tools attached to the end. These tools are used to cut roots or to chop up large chunks of debris. Mechanical devices are more effective in clearing blockages than in cleaning, and the sewers sometimes have to be flushed following a mechanical cleaning operation.

Hydro-Jet

Hydro-jets force a powerful stream of water through your pipes. The pressure that is created then forces the blockage through the pipes and out so that water can flow through once more. This method is much safer for your pipes than snaking, although it is not as effective against solid blockages. Although you can attempt hydro-jetting on your own, it is likely better to leave this task to a professional plumber who will have the experience necessary to do the job properly.

7.1.8 Corrosion Protection Methods

Coatings can provide a layer of protection against corrosion by acting as a physical barrier between the metal parts and oxidizing elements in the environment. One common method is galvanization, in which manufacturers coat the part with a thin layer of zinc.

When some metals are exposed to moisture, acids etc., they tarnish due to the formation of respective metal oxide on their surface. This process is called corrosion. Corrosion can be prevented by painting the surface, oiling, greasing, galvanizing, chrome plating or making alloys.

Methods for prevention of corrosion

The rusting of iron can be prevented by greasing, painting, galvanizing, anodizing, or oiling the surface. These methods can be classified into the following categories:

1. **Galvanization**

   Galvanized metal is coated with a thin layer of zinc to protect it against corrosion. The zinc oxidizes when it is exposed to air creating a protective coating on the metal surface.

2. **Alloying**

   It is the method of improving the properties of a metal by mixing the metal with another metal or non-metal. When iron is alloyed with chromium and nickel in stainless steel is obtained. Stainless steel does not rust at all.

3. **Painting**

   Rusting of iron can be easily prevented by coating the surface with paint which protects iron from air and moisture.

4. **Greasing/Oiling**

   When some grease oil is applied to the surface of an iron object, then air and moisture cannot come in contact with it, and hence rusting is prevented.

7.1.9 Common Organizational Policies

Maintaining plumbing systems is mandatory to keep the systems working a well condition. The products are installed in the organization as per the needs. Manufactures provides proper instructions for its maintenance and safety too. Some general policies on the organizational level related to plumbing maintenance and repairs work are stated as follows:

1. There must be proper checklist of the maintenance of the plumbing system periodically.
2. A plumbing tools inventory must be available so that it can be used as per the need of the work.
3. A plumbing system is of vital importance in any of the organization, hence in annual budgeting there should be must an allocated budget for services and maintenance of the plumbing system (As total 6 percent is maintenance cost in construction sector).
4. Annual routine plumbing system maintenance system should be made.
5. All the tools and plumbing materials should be made available on the demand.
6. All records of plumbing line and all technical details of plumbing fixtures should be properly kept in safe place for future clarifications.
7. As plumbing sector is strongly corelated to health and hygiene and hence must be taken care off.

Summary

- Plumbing troubleshooting is an important first step to making successful repairs.
- A plumbing inspection is carried out by a certified plumber or plumbing consultant. Proper inspection helps in quality and safety.
- Pipes are connecting members of the whole plumbing system. Any damage to these pipes will affect the whole plumbing system and to repair or replace pipes is not easy once in use.
- Main sewer line is a pipeline that carries the sewerage of your home to city sewer line or septic tank or cess pit.
- Traps are the part of drainage system that prevents the entry of foul smell, insects and vermin from the sewers.
- In plumbing, DWV stands for drainage, waste, and vent plumbing. These are the three types of systems that carry waste from home or allow air into pipes to facilitate the waste removal process.
- Smoke test is done in case of leakage in C.I. Pipe.
- Clogged drains and toilets, leaky faucets and pipes, problems with water heaters, poor water pressure, and a running toilet are the most typical plumbing concerns.
- A leaky faucet often results from damage to the washer that creates the seal on the tap. Tearing, dislodging, or stiffening are examples of damage. As a result of this damage, the washer no longer tightly seals, allowing a few drops of water to trickle from the faucet.
- When the toilet's internal mechanisms stop functioning properly, this frequently results in a toilet that runs continuously.
- The piping of water distribution system will need one time or another repair on a break or leak form in the line.
- Since water main breaks must be repaired as fast as possible, personnel must be trained and repair plans made in advance.
- In cold weather, a water-supply system can freeze. Because of the lack of protection against freezing and sometimes regardless of it, pipes frequently freeze in temperate zones.
- Steam thawing of frozen systems is slower than electrical thawing and should be used only when insulating materials in pipes (plastic, transits, and wood), pipe joints, or couplings make the use of electricity impractical.
- A change of water pressure can cause much discomfort to persons using the plumbing system.
- When a leak develops at a threaded joint of pipe, one of the most likely suspects is a fractured or ruptured pipe.
- Showerheads that supply an uneven or distorted stream can usually be repaired by removing the perforated faceplate and cleaning the mineral deposits from the back of the plate with fine sandpaper or steel wool.
- Sometimes a faulty seal around the valve seat can cause your toilet to run even when it is not flushed.
- Sewer cleaning methods depend on the characteristics of the wastewater being conveyed, fluctuations in wastewater flows, alignment or grade of the sewer, pipe material, size, and structural condition of the sewer.

Exercise

1. Name the important faults found in the plumbing system.

2. Discuss the testing procedure for plumbing fixtures and plumbing pipes.

3. How you will control water breaks in pipelines?

4. What are the causes and remedial actions for clogged drains and toilets?

5. List the preventing plumbing maintenance tips.

Notes

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WATER MANAGEMENT AND PLUMBING SKILL COUNCIL

8. Health and safety

Unit 8.1 - Dealing with workplace Hazards & Risks

Unit 8.2 - Fire Safety Practices

Unit 8.3 - First-aid Practices

PSC/N0136

Key Learning Outcomes

At the en d of this module, the trainee will be able to:

1. Describe the various risks and hazards at the workplace and their preventive and corrective measures
2. Employ preventive and corrective measures to protect self and others from common workplace hazards and risk

Unit 8.1 Dealing with Workplace Hazards & Risks

Unit Objectives

At the end of this Unit the trainee will be able to:

1. Differentiate between risks and hazards
2. Discuss the specific safety and health-related problems faced in domestic, commercial and institutional setups
3. List the various types of hazards (such as physical, fire, chemical compounds and electrical) that could affect the work process
4. List the various hazardous environments and common hazards that can occur during plumbing installation and maintenance along with their precautions and remedial measures
5. Discuss the importance of various types of personal protective equipment (PPE)
6. Discuss where the general health and safety equipment commonly is kept at the workplace
7. Explain the various types of safety signs and their significance in the work process

8.1.1 Safety Hazards and Risks

A **hazard** is something or someone that has the possibility of causing, serious harm, damage, or negative health effects. It has the potential to cause human injury or illness, property damage, environmental damage, or a combination of these effects.

Probability of Hazard

Frequent	Likely	Occasional	Remote	Unlikely
• Continuously experienced during operation.	• Occurs several times in career/ equipment service life.	• Occurs sometimes in career/ equipment service	• Possible to occur in career/ equipment service life.	• Possible, but improbable; occurs only very rarely during operation.

Fig 8.1 Probability of Hazards

Risk is the possibility or likelihood that someone will suffer harm or have a negative impact on their health as a result of being exposed to danger. It may also apply when there is a loss of property or equipment or when there are negative environmental repercussions.

Risk levels

1) **Extremely high** - Loss of ability to achieve the task
2) **High** - Significantly degrades mission capabilities in terms of required mission standards
3) **Moderate** - Degrades mission capabilities in terms of required mission's standards
4) **Low** - Little or no impact on the accomplishment of a mission

Difference between Hazard and Risk

Basis	Hazard	Risk
Definition	A source of possible harm or risk is referred to as a "hazard."	Risk is the likelihood that damage or injury will take place as a result of exposure to a hazard.
Safety	Even if the risk is reduced, the hazard may still exist.	In order to reduce risk, it's crucial to identify the danger and the possible harm it poses.
Example	A workplace might have a variety of hazards, including chemicals, loud noise, pollutants, electricity, etc.	Risk is the chance of suffering harm as a result of exposure to chemicals, noise, pollutants, etc.

Table 8.1 Difference between Hazard and Risk

8.1.2 Types of Hazards

The following figure represents the various hazards at the workplace:

Fig 8.2 Hazards and Risks at Workplace

8.1.3 Common Hazards

Here are some of the various hazards that plumbers encounter while working on a home or commercial plumbing project, frequently on a daily basis.

Slip and Fall Injuries	It should come as no surprise that a professional plumber working on the job could get a slip and fall injury due to slippery surfaces in homes and places of business.
Tight Spaces	As a result of the limited oxygen present in the cramped locations like crawl spaces, boilers, pits, water tanks, or pipes which are frequently inadequately aired, performing plumbing duties can be dangerous and even fatal.
Rodents and Contaminated Waters	Speaking about confined areas, disease-carrying rodents and tainted streams find them to be very alluring. Because they can result in illnesses like E. coli, exposure to these things can be exceedingly dangerous.
Chemical Hazards	Plumbers may experience significant breathing issues as a result of chemical risks like lead and asbestos found in older homes.
Tool Injuries	Any plumbing task requires the use of tools. Numerous injuries can be caused by these equipment, such as cuts from hacksaws, burns from torches, and blunt force trauma from wrenches.
High and Low Temperatures	Plumbers frequently have to operate in hot conditions. Extreme temperatures in the room can occur for a variety of reasons, including working in small quarters during cold or hot weather and hot or cold pipes.
Skin Hazards	Working with toxic chemicals, contaminated water, or even boiling water can be quite dangerous for skin.
Hearing Impairments	Plumbing jobs, particularly those for new buildings or commercial properties, can be extremely noisy. Hearing damage or even complete hearing loss can result from banging tools, loud machinery, and reverberating pipes.
Eye Hazards	Plumbers are constantly required to thoroughly inspect pipes, nuts, bolts, and fixtures. The high-pressure pipes they are working on might send objects flying across the room. They frequently also do their duties in environments that are rife with chemical and microbial risks.
Indoor Mold	Bathrooms and leaky pipes in small, poorly ventilated spaces are the perfect breeding grounds for mould since it thrives in moist settings. Because indoor mould can result in major health issues for people, it poses a considerable risk to both plumbers and inhabitants.

Fig 8.3 Common Hazard

It is significant to ensure a high level of safety that no machine tool should be used unless the risk management process outlined below is understood and applied by the user:

1. Determine the potential hazard(s) that the machine tool may produce.
2. Using the Risk Assessment Matrix, determine the likelihood and severity of the hazard(s). The following individuals have risk acceptance decision authority for the risk levels:
   a. very high
   b. very high
   c. moderate and low
3. Determine the risk-control measures that will eliminate or reduce the hazard(s). Then, implement risk control measures before and during machine tool operation to eliminate threats or mitigate their risks.
4. Monitor and evaluate the process. Enforce the established standards and risk management procedures. Evaluate the effectiveness of the control measures and make any necessary adjustments/updates.

Remedial Action Procedure

In case of any problem or hazard situation, remedial action should be completed as soon as possible. Therefore, apply these guidelines to expedite the correction of hazardous conditions.

1. Give remedial action priority to hazards with more severe loss potential.
2. Obtain target dates for correction. Use hazard classification to motivate modification.
3. Write a detailed explanation of the hazard and its potential loss severity as justification for any action requiring a significant expenditure and forward it to the person most responsible for corrective action.
4. Encourage responsible persons to take permanent corrective action (repetitive remedy is costly).
5. Ensure intermediate (temporary) safety measures are taken whenever permanent or complete remedy requires additional time.
6. At a reasonable time after the inspection is conducted and necessary action is taken, do a follow-up walk-through to ensure that the corrective action has been completed.
7. Make sure all reports are properly filed and maintained for record purposes.

Notes

8.1.4 Safety and Health-related Problems

When working with machinery, tools and equipment, employees are exposed to a variety of safety and health problems that can result in a variety of injuries. The following are the most common safety and health issues in the workplace:

- Accidents and injuries from poor illumination
- Fire/explosion caused by gas leaks, backfires and flashbacks
- Risk of elctrocution due to faulty electrical components
- Prolong exposure of excessive loud noise by machines can cause noise-induced deafness(NID)
- Burns from hot equipment parts, steam lines, and the release of hot water or steam.
- Working in awkward positions, or performing awkward manual tasks
- Working at heights (e.g., on platforms/ scaffolding or ladders)
- Shift work or extended work days
- Stress and distractions

Fig 8.4 Safety and Health-related Problems

5.1.5 Personal Protective Equipment

While working on the shop floor, every worker has to take care of several things about personal safety and their co-workers' safety. To avoid accidents and hazards, a person has to take different precautions for different situations. Firstly, on the shop floor, every person has to wear Personal Protective Equipment (PPE) for their safety.

Fig 8.5 PPE

PPE refers to the clothing or equipment designed to protect the workers/employees from shop floor hazards. It consists of items for example; hard hats, safety boots, coveralls, gloves, safety glasses, earplugs, high visibility clothing and lifejackets, fall protection, and respirators.

Common types of PPE include the following:

Eye and Face Protection

Hand Protection

Head Protection

Hearing protection

Foot Protection

Body Protection

Fall Protection

Respiratory protection

Fig 8.6 Types of Personal Protective Equipment

8.1.6 Health and Safety Equipment

Eye and Face Protection

Possible eye and face injuries include:

1. Eye injury during cutting, grinding, nailing.
2. Chemical reactions from acidic substances, solvents, or other hazardous solutions.
3. Objects fly into the eye from chains, tools, tree limbs, or ropes.
4. Radiant light during welding.

Following elements should take into consideration while selecting eye and face security equipment:

a. Capability to defend from hazards.
b. Wear suitably and comfortably.
c. Give unobstructed body movement and vision.
d. Durable
e. Permit unobstructed working of other equipment

Some of the most common types of eye and face protection equipment include the following:

Safety spectacles	Goggles	Welding shields
		
Safety spectacles having frame with plastic and impact-resistant lenses.	These are eye safety spectacles which cover the eyes tightly and give safety from dust and debris.	These are made of vulcanized fiber which is fitted in lens. Welding shields guard your eyes from fire sparkles produce during welding

Fig 8.7 Types of Eyes & Face Protection

Head Protection

Head protection in PPE terms is considered as protection against impact injury and some burn injuries.

Protective helmets or hard hats should do the following:

1. Oppose injuries by falling objects
2. Save from blows if any heavy object hits on the head
3. Guard from welding sparks

Fig 8.8 Workers wearing Hard Hats

Foot Protection

Safety boots guard the feet from puncture wounds, injuries, and slipping.

Make sure that foot protection is available where following risks are present:

1. When heavy objects roll on or fall on the feet
2. Working with pointed items like nails or wires
3. Risk of falling of molten metal on feet or legs
4. Working on warm, damp and greasy surfaces

Fig 8.9 Safety Boots

Hand Protection

Employees face potential injury to hands and arms that cannot be eliminated through engineering and work practice controls. Potential hazards include skin absorption of harmful substances, chemical or thermal burns, electrical dangers, bruises, abrasions, cuts, punctures, fractures, and amputations. Hand Protective equipment includes gloves, finger guards, and arm coverings or elbow-length gloves.

Fig 8.10 Safety Gloves

Body Protection

Body protection is principally designed to protect the torso, i.e. the chest and abdomen, from various hazards and risks which can cause injuries due to:

1. Extreme temperatures
2. Hot splashes from molten metals and other hot liquids
3. Potential impacts from tools, machinery and materials
4. Hazardous chemicals

Fig 8.9 Safety Boots

There are many varieties of protective clothing available for specific hazards. In addition, protective clothing comes in a variety of materials, each effective against particular threats, such as:

a. **The paper-l**ike fiber used for disposable suits protects against dust and splashes.

b. **Treated wool and cotton** adapt well to changing temperatures, are comfortable and fire-resistant, and protect against dust, abrasions, and rough and irritating surfaces.

c. **Leather** is often used to protect against dry heat and flames.

d. **Rubber, rubberized fabrics, neoprene, and plastics** protect against certain chemicals and physical hazards.

Ear Protection

Employees' exposure to excessive noise depends upon several factors, including:

1. The duration of each employee's exposure to the noise.
2. Whether employees move between work areas with different noise levels.
3. Whether the noise is generated from one or multiple sources.

Some types of hearing protection include:

Earplugs

They are made of waxed cotton, foam, silicone rubber or fiberglass wool. They are self-forming and, when properly inserted, they work as well as most molded earplugs.

Earmuffs

It require a perfect seal around the ear. Glasses, facial hair, long hair or facial movements such as chewing may reduce the protective value of earmuffs.

Fig. 8.12 Types of Ear Protection

Other Safety Instruments

Safety belt:

Safety harnesses protect workers from falling from heights.

Respirator:

Respirators protect the respiratory system of the wearer from the attack of poisonous gases, fumes, mist and dust.

Fig 8.13 Safety Instruments

Maintaining PPE - Proper maintenance of PPE is necessary to ensure that the equipment continues to provide the level of protection for which it is designed. Periodical inspection of the PPE for any breaks, tears, and visible signs of stress or damage is essential. Maintenance may include visual inspection, dusting, replacement, restoration, and functional testing.

The following figure represents the responsibilities of an employee regarding PPE:

PPE must be worn and used in accordance with the instructions provided	**Employees must take all reasonable steps to ensure that PPE is returned to proper storage after it has been used**	**PPE must be examined before use**
Any loss or obvious defect must be immediately reported to their supervisor	**Employees must take reasonable care of any PPE provided to them**	**Employees must not carry out any maintenance or repair of PPE unless trained and authorized to do so**

Fig 8.14 Responsibilities of the Employees Regarding PPE

8.1.7 Warning and Safety Signages

Workplace safety signage evolved with the Industrial Revolution when workplace safety became a major concern. A workplace safety sign's main function is to detect and alert employees who might be exposed to various risks. Safety signs help to communicate important instructions, reinforce safety messages, and provide emergency instructions. Workplaces that lack the necessary safety signs not only violate safety regulations but may also face hefty fines and regulatory action if they are audited by legal authorities. If an accident occurs and it is determined that proper safety signs were not present, the employer or other responsible parties could face legal consequences. It is essential to know the

meaning of safety signs. Such signs warn us of danger and allow us to take precautions to keep safe. There are four main types of safety signs:

1. Prohibition signs
2. Mandatory signs
3. Warning signs
4. Information signs
5. Fire Safety signs
6. Danger Signs

The following table represents the various signages related to health and safety measures:

S. No.	Signage	Message
1.		Basic floor sign to stop moving ahead
2.		Stop Look Out for Forklifts
3.		Eye safety warnings
4.		Fire exit sign
5.		Authorized personnel only
6.		Fire hose notification
7.		Caution signage

Continued...

S. No.	Signage	Message
8.		Caution signage
9.		Wet floor warning
10.		Watching out for step
11.		Water-saving signage

Table 8.2 Safety & Warning Signages

Notes

Exercise

Answer the following questions:

1. Explain potential risks and hazards at the workplace.

   _____

   _____

   _____

2. Explain any two types of Personal Protective Equipment.

   _____

   _____

   _____

3. What is PPE?

   _____

   _____

   _____

4. List any five safety and warning Signages used at the workplace.

   _____

   _____

   _____

Fill in the blanks:

1. _____ has the potential to cause human injury or illness, property damage, environmental damage, or a combination of these effects.
2. The purpose of _____ is to identify and warn employees who may be exposed to various hazards.
3. _____ bear more responsibility than their employees because they are held accountable for their employee's safety and well-being.
4. Earmuffs are used to protect employees from _____.

Choose the correct answers (MCQ)

a) The way of protecting individuals' well-being of health is classified as:

   1) Safety
   2) Health
   3) Adverse Situation
   4) Security

b) What are the most common risks in the workplace?

   1) Risk of electrocution
   2) Risk of injuries from faulty equipment
   3) Being hit by falling objects
   4) All of the above

c) Items included in PPE:

   1) Aviator
   2) Face Shield
   3) Uniform
   4) Caps

Unit 8.2 Fire Safety Practices

Unit Objectives

At the end of the unit, the trainee will be able to:

1. Discuss various causes of fire and precautionary activities to prevent the fire accident
2. List the different techniques that employ various methods (such as using extinguishers, water hose, sprinklers, sand bucket, wet blanket, etc.) and materials such as water, powder, foam, CO2, fire extinguishing chemical, sand, blanket, etc. used for extinguishing fire as per the type (as per class A, B, C and D)
3. Describe rescue techniques applied during a fire hazard or electrocution.

8.2.1 Causes and Prevention of Fire

Due to the number of individuals in the workplace and the various elements that could enhance the risk of a fire, the proper precautions must be taken to lower these risks.

Following are the common causes of fire in the workplace:

Fig 8.15 Common causes of Fire

How to deal with a fire emergency?

Precautions

The manager is responsible for ensuring safety from fire accidents. To be familiar with all types of evacuation procedures and fire control methods, they must attend safety workshops or fire drills organized by the organization. Some precautionary measures and awareness would include placing a "No Smoking" signboard in sensitive areas of the organization. Please note that water should not be used to extinguish a fire if the source of the fire is electrical power. Hose reels and hydrants should not be used except in the event of a fire. In the event of a fire, immediately switch off the main power supply and make an attempt to extinguish the fire with the help of available firefighting equipment.

Fig 8.16 Precaution at the Time of Fire Emergency
Source: https://learnpac.co.uk/wp-content/uploads/2016/06/fire-action.jpg

Do's and Don'ts

Do's	Don'ts
Keep the work area clean.	Do not wear inflammable materials like nylon etc.
If empty containers contain inflammable materials, fill them with water.	Do not use inflammable materials near electrical lines.
Report any unsafe situation that may cause a fire.	Never weld near combustible materials.
Watch where the sparks and metals are falling from your work.	Never leave any cable without insulation.

Table 8.3 Do's and Don'ts of Preventing Fire

8.2.2 Fire Extinguishers

Electrical fires are different from regular fires. They cannot be extinguished with water. Also, using water to put out an electrical fire is very dangerous and could lead to electrocution. To put out an electrical fire, the right type of fire extinguisher must be used. The following figure represents the different classes of fires:

Class of Fire - A

- Type of Fire - Ordinary Combustible : wood, paper, rubber, fabrics and many plastics.
- Type of Extinguisher- Water, dry powder, halon

Class of Fire - B

- Type of Fire - Flammable liquids and Gases: Gasoline, Oils, paint, lacquer and tar.
- Type of Extinguisher- Carbon Dioxide, dry powder, halon

Class of Fire - C

- Type of Fire - Fires involves live electrical equipment .
- Type of Extinguisher- Carbon Dioxide, dry powder, halon

Class of Fire - D

- Type of Fire -Combustible metals or combustible metal alloys
- Type of Extinguisher- Special Agents

Continued...

Class of Fire - K

- Type of Fire - Fires in cooking appliances that involve combustible cooking media: vegetable or animal oils and fats.
- Type of Extinguisher - Wet Chemical

Fig 8.17 Types of Fire

Water	Carbon Dioxide	Foam	Dry Powder	Wet Chemical	Fire Blanket
Cools	Smother Only	Cool and Smothers	Smother Only	Cool and Smothers	Smother Only

Fig 8.18 Types of Fire Extinguishers

Fig 8.19 Using a Fire Extinguishers

8.2.3 Fire Safety

Fire safety refers to a set of practices designed to reduce the devastation caused by fire. Fire safety measures include those used to prevent the ignition of an uncontrolled fire as well as those used to limit the development and effects of a fire once it has begun. Following are the standard practices for fire safety at workplace.

1. **Follow the emergency instruction in case of fire**
   a. Activate the ALARM.
   b. Evacuate the area.
   c. Call the fire department.
   d. Stay Calm
2. **Fight the fire only if:**
   a. You know-how.
   b. The fire is small.
   c. You are confined to the area where it started.
   d. You have a way out.
   e. You can work with your back to the exit.
   f. You have the right type of extinguisher.
   g. You feel confident that you can operate it effectively.
3. **Do not fight the fire if:**
   a. You have any doubts about fighting it.
   b. It is spreading beyond the area where it started.
   c. It could block your escape route.
4. **Precautions to be taken during the fire:**

   Following precautions are to be taken in case of fire –
   a. Switch off the main switch.
   b. Snuff the fire by throwing dry sand on it.
   c. Make sure that the fire extinguisher is operational and not expired.
   d. Do not use water to extinguish an electrical fire.
   e. Know the location of emergency exits and procedures.

Exercise

Answer the following questions:

1. Explain various types of fire and fire extinguishers.

_____

_____

_____

2. Write a short not fire safety.

_____

_____

_____

3. Explain do's and don'ts of preventing fire.

_____

_____

_____

4. List the precautions to be taken during the fire.

_____

_____

_____

5. Explain common causes of fire in the workplace.

_____

_____

_____

Fill in the blanks:

1. _____cannot be extinguished with water.
2. Safety is _____ responsibility.
3. _____ in case of fire.
4. Do not fight the fire if_____.

Unit 8.3 First-aid Practices

Unit Objectives

At the end of the unit, the trainee will be able to:

1. Discuss appropriate basic first aid treatment relevant to the condition e.g. shock, electrical shock, bleeding, minor burns, poisoning, eye injuries, etc
2. Discuss potential injuries and health problems associated with incorrect handling of tools and equipment.

8.3.1 First-aid

First aid is the assistance given to a person experiencing an unexpected illness or injury to save a life, prevent the condition from worsening, or promote recovery.

There are numerous circumstances which may require first aid, and numerous nations have legislation, regulation, or guidance which specifies a basic level of first aid provision in specific conditions. This can grasp specific training or equipment to be procurable within the work zone, (for example, an Automated External Defibrillator).

Injury	Symptom	Do's	Don't's
Fracture	• Pain • Swelling •Visible bone	•Immobilise the affected part •Stabilise the affected part •Use a cloth as a sling •Use the board as a sling •Carefully transfer the victim on a stretcher •Do not move the affected part •Do not wash or probe the injured area	•Do not move the affected part •Do not wash or probe the injured area
Electric Shock	•Pale, cold, clammy skin. It may appear grayish, and the lips and fingernails may look blue. •The pulse and breathing are rapid.	•Place his or her legs on a pillow to elevate them about 12 inches above the head •If the person is not breathing, perform CPR. •Loosen the collars and unbutton or cut away tight clothing.	•Do not move the person's head.

Continued...

Injury	Symptom	Do's	Don't's
	• The person is exhibiting disorientation or giddiness. • Nausea or vomiting may occur. • The person seems weak, with vacant eyes.	• Unbuckle the person's belt, loosen the shoes and remove all tight jewelry on the person's wrists or neck. • Cover the person with a blanket • Observe vomit or blood coming from the mouth or nose, and turn the person on his or her side to prevent him or her from choking.	•
Burns (see Degrees of Burn table)	• Redness of skin • Blistered skin • Injury marks • Headache/ seizures	• In case of electrical burn, cut-off the power supply • In case of fire, put out fire with blanket/coat • Use water to douse the flames • Remove any jewellery from the affected area • Wash the burn with water	• Do not pull off any clothing stuck to the burnt skin • Do not place ice on the burn • Do not use cotton to cover the burn
Bleeding	• Bruises • Visible blood loss from body • Coughing blood • Wound/Injury marks • Unconsciousness due to blood loss • Dizziness • Pale skin	• Check victim's breathing • Raise the wounded portion above heart level • Put a direct pressure to the wound with the help of clean cloth or hands • Remove any visible objects from the wounds • Apply bandage once the bleeding stops	• Do not clean the wound from out to in direction • Do not apply too much pressure (not more than 15 mins) • Do not give water to the victim
Heat Stroke/ Sun Stoke	• High body temperature • Headache • Hot and dry skin • Nausea/Vomiting • Unconsciousness	• Move the victim to a cool, shady place • Wet the victim's skin with a sponge • If possible, apply ice packs to victim's neck, back and armpits • Remove any jewellery from the affected area • Wash the burn with water	• Do not let people crowd around the victim • Do not give any hot drinks to the victim

Injury	Symptom	Do's	Don't's
Poisoning	• Burns or redness around the mouth and lips • Breath that smells like chemicals, such as gasoline or paint thinner • Vomiting • Difficulty breathing • Drowsiness • Confusion or another altered mental status	• Remove anything remaining in the person's mouth. • Get the person into fresh air as soon as possible. • If the person vomits, turn his or her head to the side to prevent choking. • Begin CPR if the person shows no signs of life	• Don't give syrup or do anything to induce vomiting.
Eye Injury (For Chemical Exposure)	• Pain and swelling • Bruising and redness • Problems with eye movement • Changes in eye appearance	• Immediately wash out the eye with lots of water. Use whatever is closest -- water fountain, shower, garden hose. • Get medical help while doing this, or after 15 to 20 minutes of continuous flushing	• Don't rub eyes • Don't bandage the eye
Eye Injury (For a Foreign Particle in Eye)	• Pain and swelling • Bruising and redness • Problems with eye movement • Changes in eye appearance	• Pull the upper lid down and blink repeatedly. • If particle is still there, rinse with eyewash. • If rinsing doesn't help, close eye, bandage it lightly, and see a doctor.	• Don't rub the eye.

Table 8.4 First-aid Procedures

8.3.2 Safety and Health Issues while handling Tools and Equipment

Workers depend on their employers to provide safe working conditions, and part of that process entails routine inspections of workplaces, vessels, etc., as well as maintenance of the machinery used at and on all of these locations. Employers must also make sure that the employees they hire have the necessary credentials and training. Finally, companies need to make sure that their staff members are adhering to the right safety protocols and guidelines and not working too much.

These kinds of accidents can result in a variety of severe injuries, such as:

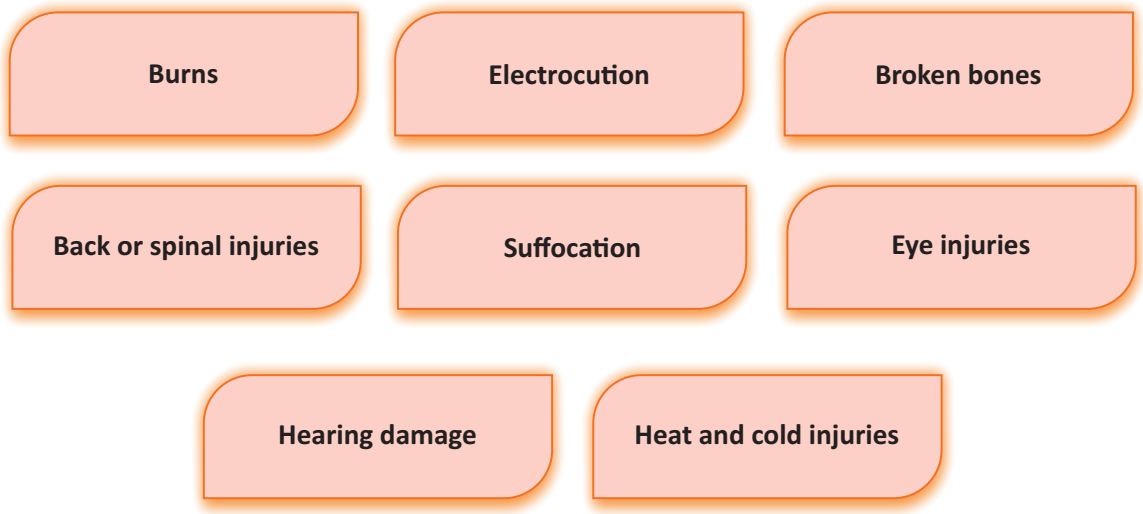

Fig 8.20 Safety and Health Issues

Notes

Summary

- Workplace safety is one of the most significant concerns for any manufacturing company or facility. Getting it right can improve the overall performance of the operation and lead to growth.
- It is the responsibility of everyone, whether employer or employee, to keep the workplace clean, healthy, and safe.
- A hazard is something or someone that has the potential to cause damage, harm, or adverse health effects.
- Risk is the possibility or likelihood that someone will suffer harm or have a negative impact on their health as a result of being exposed to danger. It may also apply when there is a loss of property or equipment or when there are negative environmental repercussions.
- Workplace safety signage evolved with the Industrial Revolution when workplace safety became a major concern. The purpose of a workplace safety sign is to identify and warn employees who may be exposed to various hazards.
- Employers bear more responsibility than their employees because they are held accountable for their employee's safety and well-being.
- PPE refers to the clothing or equipment designed to protect the workers/employees from shop floor hazards. It includes items such as hard hats, safety boots, coveralls, gloves, safety glasses and goggles, earplugs, high visibility vests, lifejackets, fall protection, and respirators.
- Fire safety refers to a set of practices designed to reduce the devastation caused by fire. Fire safety measures include those used to prevent the ignition of an uncontrolled fire as well as those used to limit the development and effects of a fire once it has begun.
- Electrical fires are different from regular fires. They cannot be extinguished with water. Also, using water to put out an electrical fire is very dangerous and could lead to electrocution. To put out an electrical fire, the right type of fire extinguisher must be used.
- First aid is the assistance given to a person experiencing an unexpected illness or injury to save a life, prevent the condition from worsening, or promote recovery.
- Workers depend on their employers to provide safe working conditions, and part of that process entails routine inspections of workplaces, vessels, etc., as well as maintenance of the machinery used at and on all of these locations.

Notes

Exercise

Answer the following questions:

1. Explain first-aid procedures to deal with bleeding and burns.

2. List some health and safety issues that occur while handling tools and equipment.

Skill India
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सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
National
Skill Development
Corporation
Transforming the skill landscape

WATER MANAGEMENT AND PLUMBING SKILL COUNCIL

9. Working Effectively With Others

Unit 9.1 - Work and Communicate Effectively at Workplace

Unit 9.2 - Work in a Disciplined and Ethical Manner

Unit 9.3 - Uphold Social Diversity at the Workplace

PSC/N0137

Key Learning Outcomes

At the en d of this module, the trainee will be able to:

1. Apply effective communication techniques
2. Demonstrate teamwork and a positive attitude
3. Demonstrate responsible and disciplined behaviour

Unit 9.1 Work and Communicate Effectively at Workplace

Unit Objectives

At the end of this Unit the trainee will be able to:

1. State the importance of effective communication in the workplace
2. Describe the typical organisational hierarchy and the various categories of people that one is required to communicate and coordinate with
3. List various components of effective communication
4. State the importance of using inclusive language (verbal, non-verbal and written) that is gender, disability and culturally sensitive
5. State the importance of teamwork and developing effective working relationships for professional success
6. Discuss the importance and ways of managing interpersonal conflict effectively
7. Discuss how to express and address grievances appropriately and effectively
8. State the importance of ethics and discipline for professional success.
9. Explain what constitutes disciplined behaviour and integrity for a working professional
10. Discuss the legislation, standards, policies, and procedures relevant to own employment and performance conditions
11. Discuss importance of dress code in organisations

9.1.1 Significance of Effective Communication

Effective communication is required for all employees in the organization to perform basic management functions and carry out their jobs and responsibilities. The ability to communicate effectively at work is essential regardless of industry. Effective communication entails more than just exchanging information; it also encompasses the emotion and intentions behind the facts and conveying a message. Therefore, communicating more clearly and effectively requires learning some essential skills. Learning these skills can assist employees in developing stronger bonds, gaining more trust and respect, improving teamwork, problem-solving, and overall social and emotional health. As a result, we can state that "effective communication is a foundational component of successful organizations."

Build strong professional relationships with co-workers and clients	Helps to express thoughts and convey clear message	Manage and assist the team where required
Motivate and boost teamwork and lead to better project collaboration	Enhance leadership and negotiation skills	Bridge gaps between clients, colleagues, and partners
Recognize each others' good work and give constructive feedback	Resolves issues and conflicts	Improve productivity by sharing information and ideas

Fig 9.1 Importance of Effective Communication

9.1.2 Communication Process

The process of communication is a dynamic structure that explains how a message is transmitted between a sender and a receiver via various communication channels. Its purpose is to ensure that the receiver accurately decodes the message and can provide feedback with precision and convenience.

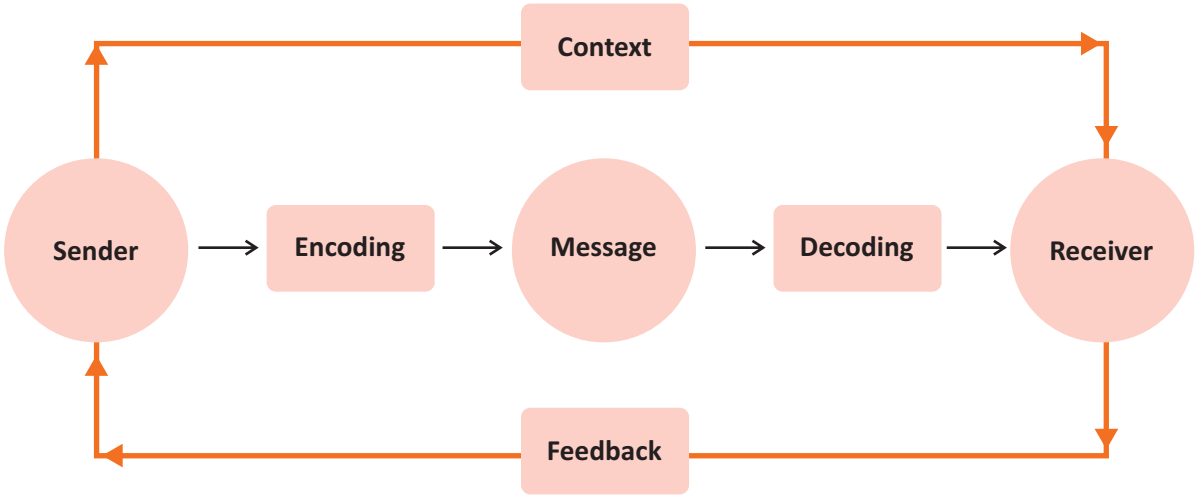

Fig 9.2 Process of Communication

As demonstrated in the exhibit above, there are 8 elements of communication:

Sender
Who sends the message or is the source of the message.

Encoding
Transferring the message into a format that can be shared. It includes the language or tone chosen.

Message
The idea being communicated by the sender.

Channel
The mode chosen for communicating. Example- phone, oral, text, gestures, or writing.

Decoding
It means how the sender comprehends and understands the message that sender has communicated

Receiver
The idea being communicated by the sender

Feedback
The revert or the response communicated by the receiver to the source/sender after having decoded the message

Context
The environment, situation, or the circumstances in which the communication is happening

Fig 9.3 Elements of Effective Communication

9.1.3 Communication Barriers

All of the elements depicted above can also act as a barrier to communication. Communication barriers are factors that prevent a message from being received in the way the sender sent it. People frequently face the problem of the message being received in an assumed manner when communicating. As a result, it leads to miscommunication and misunderstandings. Let us look at the table below to understand four significant barriers to communication.

	**Physical or Environmental Barriers** • The barriers in the surroundings or in the environment are the physical barriers. • Example- Noise in the surroundings, the physical distance between the sender & receiver, defects in the communication system like network problems, poor signal, etc.
	**Language Barriers** • This barrier arises due to the different language or differences in the language of the sender and receiver. • This problem often occurs because of the different meanings perceived in the same word, or the receiver does not understand the jargon used in the message. The language barrier is not limited to spoken language. It also includes body language. • The same message is perceived differently by the receiver said with different body language.
	**Psychological Barriers** • Barriers or problems arising due to the differences in perception, ego clashes, prejudices, state of mind, poor past experiences, behaviors, attitudes, moods, and value systems are psychological barriers. • These barriers are generally exceedingly difficult to overcome.
	**Socio-Cultural Barriers** •Sometimes the differences in social or cultural norms cause communication problems. •These include how the people generally speak, wear, follow customs, behave, or eat is not completely understood by the receivers who are not accustomed to the differences. •For example, some communities are louder and

Table 9.1 Potential Barriers in Communication

9.1.4 Inclusive Languages

An inclusive language avoids stereotypes, slang, and idioms that stigmatise certain racial, gender, socioeconomic, and ability-based groups of people. When used, communicate with more people by speaking and writing in a way that is welcoming to all and that everyone can comprehend.

Any type of communication style is effective only when one knows how to actively listen, observe and empathize.

Verbal

- Use strong, confident speaking voice.
- Use active Listening
- Avoid filter words
- avoid industry jargon when appropriate

Non-verbal

- Notice how your emotions feel physically
- Be intentional about your nonverbal communications
- Mimic nonverbal communications you find effective

Visual

- Ask others before including visuals
- Consider your audience
- Only use visuals if they add value
- Make them clear and easy to understand

Written

- Strive for simpilcity
- Is to the point and avoid unnecessary repetition
- Avoid offensive language

Fig 9.4 Inclusive Languages

9.1.5 Organizational Structure

An organizational structure is a system that defines how specific activities are directed in order to achieve an organization's goals. These activities may include rules, roles, and responsibilities. The organizational structure also governs how information flows within the company. There are numerous types of organizational reporting structures, each with its own set of benefits and drawbacks. The reporting structure is chosen based on the organizational requirements. The following are the top organizational reporting structures.

Hierarchical organizational structure

- It is a pyramid-like top-down management structure.

Functional organizational structure

- It is a business structure that divides a company into departments based on areas of expertise.

Continued...

Divisional or product organizational structure

- In a product-based structure (also known as a divisional structure), employees are assigned to self-contained divisions based on the -market, product line and geography.

Line-and-staff organizational structure

- In this structure, authorities (e.g., managers) establish goals and directives that are then carried out by employees and other workers.

Flat organizational structure

- A flat organizational structure means that there are few (if any) levels of management between the workforce and the highest-level managers.

Matrix organizational structure

- A matrix organization is a work structure in which team members report to multiple leaders.

Network organization structure

- It is a type of internal structure that prioritizes communication and relationship goals over hierarchy.

Fig 9.5 Types of Organizational Structure

Notes

Significance of Effective Communication with Team members

It is significant to convey information as per defined protocols to the authorized person's/team members, as it reduces communication gaps, strengthens alignment with all levels of leadership, and ensures that employees receive consistent messages. The Communication Protocol specifies the types of information to be communicated to the organization, as well as the person(s) in charge of communicating specific topics. The audience, frequency, and suggested communication vehicles are also discussed. The Protocol, which is prominently displayed in all common areas such as lobbies and conferences, and is distributed to all new hires, ensures that communications align with the company's key strategic priorities.

Effective communication with the supervisor is essential for professional development and advancement. Refer to the exhibit below for tips on communicating with the supervisor effectively.

Listen to your supervisor carefully and understand the goals and requirements

Report the facts and problems and ask for possible solutions if necessary

In case of an unsuccessful attempts, highlight it to the supervisor rather than covering it up

Stay open to feedback and keep a positive attitude

Inform immediately about any situation that needs attention

Follow the code of conduct that has been established by the organization

Igreet the supervisor with a smiling face

Don't argue with the supervisor in front of other employees

Concisely put your point of view, concerns, and requests in a polite and respectful manner

A loud voice tone suggesting impatience, sarcasm or taunt, is not acceptable by anyone

I Avoid words and topics which may offend someone

Communicate regularly with your supervisor to develop and maintain a successful professional relationship

Fig 9.6 Effective Communication with Superior

Following proper communication, rules are critical to keeping a **healthy relationship with colleagues and co-workers.** The quality of the relationship with colleagues and co-workers will depend on the behavior you demonstrate while interacting with them. A relationship built on trust, excellent, clear communication, polite language, and appropriate behavior helps you succeed at work.

Greet everyone with a smile and positive body language.	Listen actively and avoid jumping to conclusions	Offer help to a new colleague in your crew
Show courtesy and respect to colleagues	Speak in a polite and respectful tone	Make an eye contact while you speak
Use positive words and body language	Appreciate each other's work	Learn from your team members and collaborate with them
Keep commitments made to your colleagues or team members	Inform your colleagues in case of delay in the work	Do not be a grump. Leave your bad mood out of the worksite
Do not engage in any kind of gossip	Do not disturb others when they are working	Do not waste your time and others' time by holding conversations which are not related to work

Do not interrupt when the other person is speaking. Wait for them to complete	Avoid controversial conversations

Fig 9.7 Effective Communication with Colleagues

Notes

9.1.6 Managing and Coordinating with Team

Coordination is the core of every successful organization. It is basically a mechanism or strategy that enables different entities to work together. Coordination helps to maintain and improve efficiency while striving for a common goal or target. Hence, team management and coordination are of utmost importance for work integration.

Set Clear Goals	Be open about everything	Communicate the Purpose of Work.
Create a Shared Vision	Listen to Everyone's ideas	Encourage Team to Socialize For Better Understanding
Show How Work Aligns with Larger Goals	Make Sure Everyone is on the Same Page	Know the Strengths of Your Team
Reach Out for Help and Support for Each Other	Engage in meaningful (in-person) dialog	Show Appreciation and Recognisation for the Team's Effort
Hold Regular and Effective Team Meeting for Problem Solving	Stop Micromanaging, Allow others to make decisions together	Ask Everyone for Feedback
Develop a Review Process	Celebrate as a Team	Share the Workload
Set Ground Rules	Be Willing to Steer the Conversation	Build Trust and Boost Transparency among the Team Members

Fig 9.7 Effective Communication with Colleagues

9.1.7 Individual and Team Goals

Goal setting is undoubtedly one of the most effective motivational tools in the organization. Almost every organization requires employees to set goals regularly. Even when times change, continuously updating and setting goals is necessary to keep your business on track. Goals in each organization should be **S.M.A.R.T: specific, measurable, actionable, realistic, and timely**. It helps you and your team feel a stronger sense of purpose and direction. In addition, setting goals in place will help you and your team feel productive with each bit of accomplishment and ensure that more significant production stays on track.

Individual goals are significant because they give direction to the employees. While team goals are great for the overall guidance, personal goals will allow your team members to take distinct paths to digest the larger plan and turn it into action.

Team goals are necessary to guide the entire organization. It includes broad objectives that can be broken down into team projects and initiatives with individual key results. In addition to helping the organizations achieve their objectives, setting team goals also **boost employee engagement, productivity and retention by ensuring that every team member has a complete understanding of their role in the overall approach.** This also **saves time and improve efficiency.** In addition, setting team goals also offers organizations the following benefits:

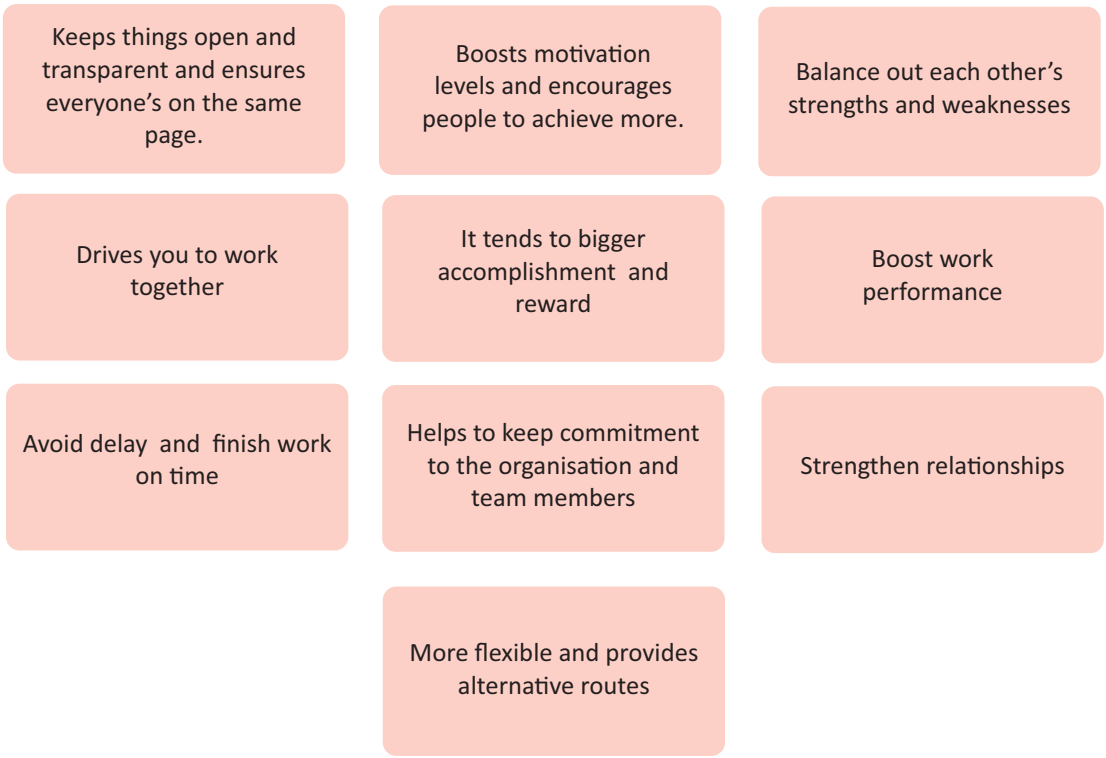

Fig 9.9 Benefits of Team Goals in an Organisation

Notes

Exercise

1. **Fill in the blanks:**
   a) _____is a building block of successful organizations.
   b) A healthy relationship with colleagues is built on _____, _____ and_____.
   c) _____ is a part of your organization's duties to its community and stakeholders.
   d) Sharing information helps employees to limit the _____ gap.
   e) _____ is a mechanism or strategy that enables different entities to work together.
   f) _____ facilitates meaningful and necessary communication for employee _____and manage the communication flow within and outside the organization.
   g) Fill in the Blanks-
   h) _____ is a set of rules indicating the proper and polite way to behave at work.
   I) _____include how the people generally speak, wear, follow customs, behave by the receivers who are not accustomed to the differences.
   j) _____ is the response communicated by the receiver to the source/sender after having decoded the message.
   k) The quality of the relationship with colleagues and co-workers will depend on the _____ demonstrate while interacting with them.
2. Goals in each organization should be:
   a) Specific, monthly, adjustable, realistic, and timely
   b) Smart, measurable, actionable, realistic, and timely
   c) Specific, measurable, actionable, realistic, and timely
3. The following are the types of communication at workplace, except:
   a) Employer – employee
   b) Colleagues
   c) Stakeholders
   d) Customer – friend
4. Which one is not the correct way of verbal and written communication?
   a) Short
   b) Irrelevant
   c) Simple
   d) Direct
4. Differentiate between team goals and individual goals.
5. What is effective communication?
6. How language barriers create gaps in workplace?
7. List any two tips for communicating effectively with superiors.

Unit 9.2 Work in a Disciplined and Ethical Manner

Unit Objectives

At the end of the unit, the trainee will be able to:

1. Discuss the importance and ways of managing interpersonal conflict effectively.
2. Discuss how to express and address grievances appropriately and effectively.
3. State the importance of ethics and discipline for professional success.
4. Explain what constitutes disciplined behaviour and integrity for a working professional.
5. Discuss the legislation, standards, policies, and procedures relevant to own employment and performance conditions.
6. Discuss importance of dress code in organisations.

9.2.1 Importance of Work Ethics and Discipline

A professional code of ethics establishes an organization's ethical guidelines and best practices for maintaining honesty, integrity, and professionalism. Violations of the code of ethics can result in sanctions, including termination, for members of an organization. The following figure explains the standard practices and professional code of ethics follow in every organization.

Fig 9.10 Professional Code of Ethics

Employee discipline isn't about power or punishment. It is about making the workplace safe and enjoyable for both employees and management. Discipline is most effective when there is mutual trust between managers and employees. It all begins with clear communication and continues with consistency. Discipline assists employees in correcting any shortcomings to become valuable, contributing members of the workforce. Documentation created as a result of the disciplinary process can also help an employer protect itself if termination or other adverse employment decision is required. Here are the ways to maintain workplace discipline in the organization while maintaining employee respect:

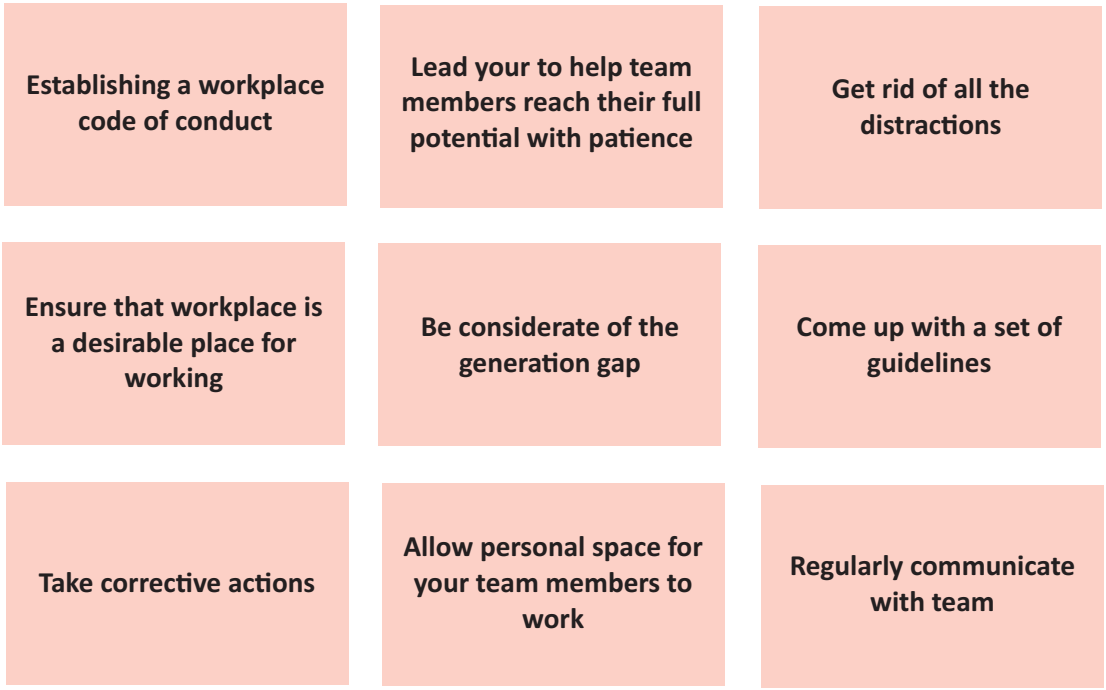

Fig 9.11 Tips for Maintaining Discipline at Workplace

Notes

9.2.2 Managing Conflicts at Workplace

Dealing with conflict at the workplace is inevitable. The ability to recognize conflict with your colleagues, understand its nature, and try to bring a quick and fair resolution to the conflict is critical to anyone who works in a team. **Conflict management** is a crucial skill that enables an individual to handle confrontations tactfully and constructively. It aims to yield a positive result from disputes and disagreements that occur between people in the workplace and resolve the conflict in a way that respects everyone's wants and needs. At some point, we need skills for managing conflict in the workplace. The following tips can help us resolve the conflict or a disagreement in that situation.

Stay calm during a conflict	**Control your anger by staying conscious of the situation and swaying with the flow**	**Do not try to assume others' perspectives. Give them the opportunity to speak and one must listen**
Leave the site for a time-being, if the situation is heating up	**Sometimes it is not necessary to argue. Letting the moment pass shall avoid the conflict**	**Keep an open mind and compromise where necessary**
Mind your language if you enter an argument. Never say something which you may need to regret later	**Remember, everyone is different and can have a different point of view to yours**	**Try to look at the situation from others' point of view**
Determine the way in which both the parties could be mutually benefitted	**Do not try to overpower your intent**	**If the conflict intensifes, let a common lead help resolve the conflict**

Fig 9.12 Tips for Managing Conflicts

Notes

9.2.3 Grievance Management

Grievances result in collective disputes when they are not resolved timely. Also, this lowers the morale and efficiency of the employees. Frustration, employee dissatisfaction, low productivity, lack of interest in work, high absenteeism, etc. might be a result of unattended grievances. In short, grievance arises when the organization does not fulfill employees' expectations, resulting in a feeling of discontentment and dissatisfaction. This dissatisfaction must have cropped up from employment issues and not from personal issues.

A grievance may result from the following factors-

a) **Working Conditions and Safety:** These consists of any complaint or grievance that directly addresses the employees' work environment. These can include everything from unsafe working conditions to difficult and indifferent managers.

b) **Unreasonable Management Policies:** If employees believe that a particular policy is unfair or unreasonable, they will want their concerns addressed. Such policies can include a gap in production standards or overtime regulation compliance.

c) **Violations of Rules and Policies:** These are related to any organizational rules which the employees feel are being violated by other workers and/or middle or senior management.

For addressing grievance, Plumber General should adopt the following approach to manage grievance effectively:

1. Complaint: As soon as the grievance arises, it should be identified and resolved. This lowers the detrimental effects of grievance on the employees and their performance.
2. Acknowledging grievance: Acknowledge the grievance put forward by the employee as a manifestation of true and genuine feelings of the employees. Acknowledgment implies that you are eager to look into the complaint impartially and without bias. This creates a conducive work environment with instances of grievance reduced.
3. Gathering facts: Gather relevant and adequate facts that explains the nature of the grievance. These facts must be recorded to be used at a later stage of grievance redressal.
4. Examining the causes of grievance: The actual cause of resentment should be identified. Consequently, remedial actions should be taken to prevent the repetition of the grievance.
5. Decisioning: After identifying the causes of grievance, an alternative course of action should be suggested to manage the grievance. The effect of each action on the existing and future management policies and procedures should be analyzed, and accordingly, the manager should take a decision.
6. Execution and review: The manager should implement the decision quickly, ignoring the fact that it may or may not hurt the concerned employees. After implementing the decision, a follow-up must ensure that the grievance has been resolved completely and adequately.

Fig 9.13 Grievance Addressing Process

An effective grievance procedure ensures a pleasant work environment because it redresses the grievance to the mutual satisfaction of the employees and the supervisors.

9.2.4 Disciplined Behaviour and Integrity

The behaviors of employees in the workplace directly impact the operations and success of a business. Professional behaviour leads to a higher status of an organisation and also boosts the morale of the employees.

Responsible and disciplined behaviour will ensure good maintenance at the workplace, the satisfaction of the customers and an overall conducive atmosphere to continue with the activities to the benefit of all.

Responsible behaviour at workplace includes:

Working well as part of a team or group.	Displaying a positive attitude toward co- workers, the workplace and the tasks of the job.	Maintaining a clean and suitable appearance.
Showing respect for others and respect for individual differences.	Being on time for work and completing the tasks on time.	Following organisation rules and policies.
Reporting to the supervisor as and when necessary.	Helping others.	Showing integrity and honesty
	Being disciplined, responsible and accountable	

Fig 9.14 Responsible Behaviour

Employers value individuals who exhibit integrity since it is a desirable quality in the workplace. Integrity-driven individuals are more inclined to work for a company with trustworthy workplace culture. When a person upholds their moral and ethical standards even when they are not in the spotlight, that person is said to have integrity. In whatever circumstance they encounter in life, a person with integrity prefers to act honorably.

Graciousness	Honesty	Trustworthiness
Responsibility	Patience	Helpfulness

Fig 9.15 Character Traits Related To Integrity

9.2.5 Importance of Dress Code

Organizations can let employees know what they consider proper work clothing by using dress codes. An employer can specify expectations for the image it wants its employees to project through a dress code or appearance policy. Uniforms may be worn according to formal or informal dress codes. The way one is dressed speaks volumes about their professional image and attributes.

Dress should be washed clean and stains free, untorn, and neatly ironed. Clothes should fit properly. Wearing clothing that is too big or small in size can make a person look shabby.

- Clean t-shirt or flannel
- Denim jeans or dickies type work pants.
- Good work boots.
- Thick cotton socks
- Good pair of canvas glove
- Approved hard hat at all times
- Safety Glasses

Fig 9.16 Dress code for a Plumber

Notes

Exercise

Answer the following questions:

1. Write a short note on work ethics and workplace etiquette.

2. List any 3 ways of maintaining discipline at the workplace.

3. What is conflict management?

4. Explain confidentiality in the workplace.

5. How language barriers create gaps in workplace?

Notes

Unit 9.3 Uphold social diversity at the workplace

Unit Objectives

At the end of the unit, the trainee will be able to:

1. Explain the impact of gender, disability, cultural and age-related biases, stereotyping at the workplace and in society.
2. List the different types of disabilities and the challenges faced by persons with disability (PwD).
3. State the laws, acts, provisions and schemes defined for PwD by the Government bodies.
4. Discuss gender, disability and cultural biases, stereotypes and impact on others
5. Discuss basic gender concepts such as gender power relations, gender roles, access and control, gender sensitivity, gender equity and equality.
6. Discuss the importance of gender sensitivity and equality.
7. List the indicators of harassment and discrimination based on gender, disability, caste, religion or culture that occurs at a typical workplace.
8. State general organisational norms and procedures applied to protect against harassment and discrimination.
9. Discuss the importance of reporting incidents of harassment and discrimination to appropriate authority.

9.3.1 Sensitivity for Person-With-Disability (PwD)

Disabled workers are a part of the diversity in today's workforce. However, being disabled does not imply that the individual is incompetent or unable to do his/her job. In fact, being disabled simply means the person has an impairment, which can be anything ranging from physical to psychological. Disabled co-workers and employees are not any different in that they are there to earn a living, advance their career, and better the organization through their contributions.

Listed below are some tips for interacting and communicating with people with disabilities.

Speak directly rather than through a companion or the sign language interpreter who may be present.	**Offer to shake hands when introduced.**	**If you offer assistance, wait until the offer is accepted. Then listen or ask for instructions.**
Address people with disabilities by their first names only when extending that same familiarity to all others.	**Do not lean against or hang on someone's wheelchair or scooter as people with disabilities treat their wheelchairs or scooters as extensions of their bodies.**	**Listen attentively when talking with people who have difficulty speaking and wait for them to finish.**

Continued...

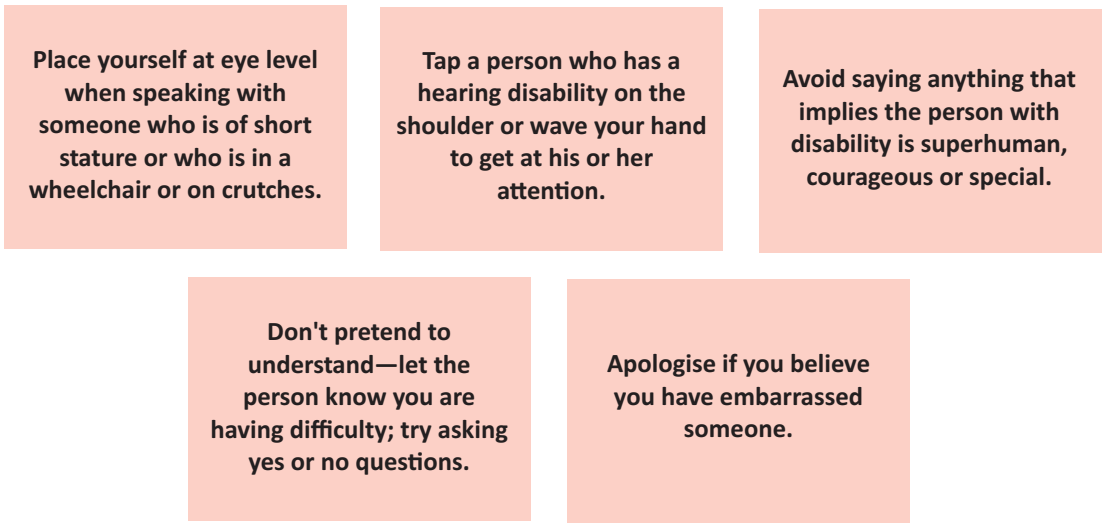

Fig 9.17 Communicating and Interacting with PWD

The RPWD Act, 2016 provides that "the appropriate Government shall ensure that the PwD enjoy the right to equality, life with dignity, and respect for his or her own integrity equally with others." The Government is to take steps to utilize the capacity of the PwD by providing appropriate environment.

Gender inequality in an organization's is a complex phenomenon that can be seen in organizational structures, processes, and practices. Following chart explains gender based issues in workplace:

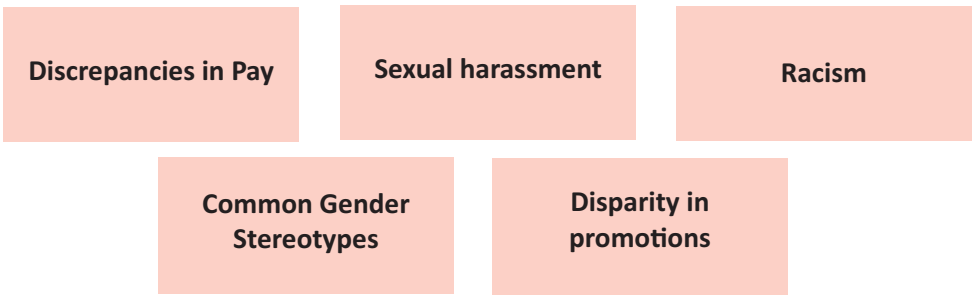

Fig 9.18 Gender based Issues at Workplace

Females with disabilities are subjected to multiple layers of discrimination. Based on their gender and disability status, they often face double discrimination. They often face disproportionately high rates of gender-based **violence, sexual abuse, neglect, maltreatment and exploitation.** The exclusion experienced by women and girls with disabilities is a social issue that requires active participation of everyone.

It is important to follow organizational standards related to PwD at workplace because, it:

1. Protects them from any physical harm or any accidents
2. Provides them equal rights
3. Protects them from any kind of discrimination and racism
4. Provides security from any kind of violence and harassments
5. Protects their respect and dignity
6. Provides equal opportunities to deserving candidates

9.3.2 Gender Sensitivity

Gender sensitization is vital because representation is important. Representation of a person and community advocates equality and adds a sense of inclusion to the previously marginalized community. For a healthy performance-oriented culture, organizations need the correct mix of talent which is not bound by any gender. More than ever, accountability has become important now, organizations only have today to make the changes that count, as tomorrow they won't be able to hide under the pretext of ignorance. Each member of an organization seeks out to learn and grow at their workplace, and an insensitive place of work not only hinders that but also tends to become an unfriendly workplace. Gender sensitization is extremely significant as it helps the employees feel appreciated and cared for within the organization. Lastly, for the betterment of society, organizations have got an ethical responsibility in shaping the current structures by breaking the old norms. Organizations that do not emphasize on gender sensitization usually develop cultures where inequality and discrimination becomes normal. This kind of culture leads to a higher attrition rate, a higher rate of employee absenteeism, etc. Such policies also propagate the presence of a superior gender.

The concept of gender sensitivity shows the path to reduce barriers to personal and economic development created by gender differentiation. In addition, it helps to generate respect for individuals regardless of their gender.

Gender sensitivity is not about fighting women against men. On the contrary, gender-sensitive education, benefits members of all genders. It helps the individuals determine what assumptions are valid and which are stereotyped generalizations in matters of gender. Gender awareness not only requires intellectual efforts but also sensitivity and open-mindedness. It opens up the broadest possible range of life options for both women and men.

Some of the best practices followed to stay gender-sensitive would be to

- Use respectful language while communicating with each other. Do not reinforce gender stereotypes.
- Provide fair opportunity to everyone irrespective of their gender
- Do not promote creating gender-specific social groups.
- Neither victimize nor patronize based on gender

Notes

9.3.3 Rights and Duties at Workplace concerning PwD

The following chart explains the rights and duties at the workplace with respect to PwD:

Rights	Duties
• To an accessible workplace free of hazards and risks • To complete information about the job • To information, education, training and safely equipment that reduces risks and hazards • To equal access to benifits, conditions of employement and promotional opportunities • To special safety procedures and considerations that may relate to one's disability in case of emergency • To be treated with dignity and respect • To special tools and services that be needed to accomodate a disability on the job or in the community	• To provide complete and honest information as it relates to the job • To request reasonable accomodation or assistance if needed • To practice safely procedures and use equipment to reduce risks to self and others • To report illness or injury promptly • To cooporate and work with rehabitation professionals and employes in good faith regarding return to work. • To use the access and services provided to be fully productive • to advocate, educate and collaborate with legel, service and other systems to meet needs and resolve conflicts

Fig 9.19 Rights and Duties at Workplace with Respect to PwD

9.3.4 Different Types of Disabilities

Some examples of common disabilities are:

- Vision Impairment
- Deaf or hard of hearing
- Mental health conditions
- Intellectual disability
- Acquired brain injury
- Autism spectrum disorder
- Physical disability.

Fig 9.20 Different types of Disabilities

Challenges faced by PwD

- A physical environment that is not accessible
- Lack of relevant assistive technology (assistive, adaptive, and rehabilitative devices),
- Negative attitudes of people towards disability,
- People sometimes stereotype those with disabilities, assuming their quality of life is poor or that they are unhealthy because of their impairments.
- Steps and curbs that block a person with mobility impairment from entering a building or using a sidewalk
- Absence of a weight scale that accommodates wheelchairs or others who have difficulty stepping up

Fig 9.21 Challenges faced by PwD

9.3.5 PwD Policies

The Indian Government respects equality and therefore no discrimination should be made on the ground of disability. The Constitution secures to the citizens including the disabled, a right to justice, liberty of thought, expression, belief, faith and worship, equality of status and opportunity and for the promotion of fraternity. No disabled person can be compelled to pay any taxes for the promotion and maintenance of any particular religion or religious group. To enforce the same, the government has passed laws to protect the disabled and their right to equality. The laws pertaining to disables are as follows:

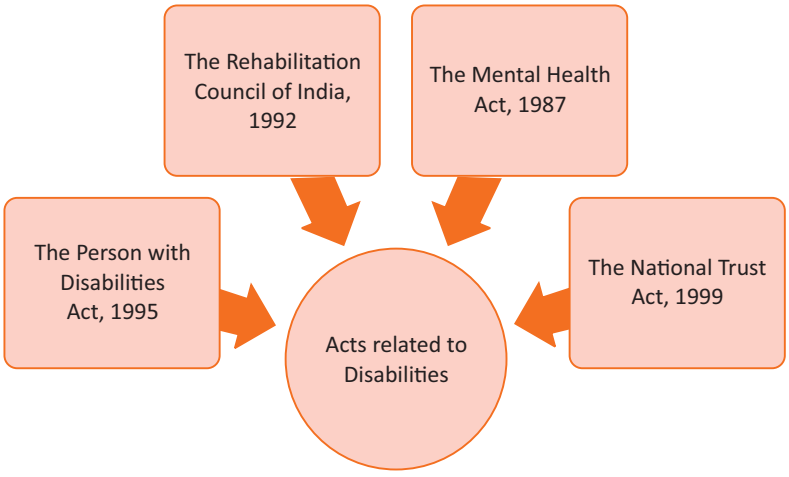

Fig 9.22 Acts related to Disabilities

Summary

- Effective communication is required for all employees in the organization to perform basic management functions and carry out their jobs and responsibilities.
- It is extremely difficult for Quality Managers to manage their teams and coordinate efforts for successfully completion of a project without strong interpersonal communication skills. A project cannot be successful if there is no communication.
- The process of communication is a dynamic structure that explains how a message is transmitted between a sender and a receiver via various communication channels. Its purpose is to ensure that the receiver accurately decodes the message and can provide feedback with precision and convenience.
- Communication barriers are factors that prevent a message from being received in the way the sender sent it. People frequently face the problem of the message being received in an assumed manner when communicating.
- Effective communication with your supervisor is crucial to your professional development and career advancement. Refer to the exhibit below for tips on communicating with the supervisor effectively.
- Following proper communication, rules are critical to keeping a healthy relationship with colleagues and co-workers. The quality of the relationship with colleagues and co-workers will depend on the behavior you demonstrate while interacting with them.
- Transparently sharing data and information ensures that everyone is in the loop and aware of any potential issues with the business, product, or service that can be addressed collaboratively. Employees might have lots of knowledge that is crucial for the organization and other employees. Sharing information helps them connect, perform better, and become more vital as professionals.
- Organizational communication can be divided into two categories: formal and informal communication.
- Emotional outbursts at work could be caused by work-related issues or by stressors from our personal lives spilling over into our work lives. Handling our emotions (especially negative ones) at work is frequently regarded as a test of our professionalism.
- An organizational structure is a system that defines how specific activities are directed in order to achieve an organization's goals.
- . The workflow of an organization consists of the processes that must be completed, the people or other resources that are available to perform those processes, and the interactions between them.
- Communication policies of an organization establish expectations and manage the flow of communications within and outside the organization. As a result, it facilitates meaningful and necessary communication for employee productivity and morale without restricting employees' feeling intimidated and powerless.
- Goals in each organization should be S.M.A.R.T: specific, measurable, actionable, realistic, and timely. It helps you and your team feel a stronger sense of purpose and direction. In addition, setting goals in place will help you and your team feel productive with each bit of accomplishment and ensure that more significant production stays on track.
- Team performance evaluation is a key factor in inspiring teams, improving the quality of work, and keeping them motivated. It is the best channel to understand how the team is performing and an effective measure to get feedback about how production is going, whether the employees are working positively towards achieving goals, and what can be done to improve employees' engagement.

Summary

- A professional code of ethics establishes an organization's ethical guidelines and best practices for maintaining honesty, integrity, and professionalism. Violations of the code of ethics can result in sanctions, including termination, for members of an organization.
- Work ethics are the morals or principles that govern a person's or group's behavior, whereas etiquette is a set of rules indicating the proper and polite way to behave at work.
- Dealing with conflict at the workplace is inevitable. The ability to recognize conflict with your colleagues, understand its nature, and try to bring a quick and fair resolution to the conflict is critical to anyone who works in a team.
- Discipline is most effective when there is mutual trust between managers and employees. It all begins with clear communication and continues with consistency. Discipline assists employees in correcting any shortcomings to become valuable, contributing members of the workforce.
- Confidentiality is important for legal and reputational reasons, but it is also important because future employment may be contingent on it.
- Disabled co-workers and employees are not any different in that they are there to earn a living, advance their career, and better the organization through their contributions.
- The RPWD Act, 2016 provides that "the appropriate Government shall ensure that the PwD enjoy the right to equality, life with dignity, and respect for his or her own integrity equally with others." The Government is to take steps to utilize the capacity of the PwD by providing appropriate environment.
- Gender inequality in an organization's is a complex phenomenon that can be seen in organizational structures, processes, and practices.
- Females with disabilities are subjected to multiple layers of discrimination. Based on their gender and disability status, they often face double discrimination.
- For a healthy performance-oriented culture, organizations need the correct mix of talent which is not bound by any gender.
- Use respectful language while communicating with each other. Do not reinforce gender stereotypes.
- Gender sensitivity is not about fighting women against men. On the contrary, gender-sensitive education, benefits members of all genders. It helps the individuals determine what assumptions are valid and which are stereotyped generalizations in matters of gender.

Notes

Exercise

1. **Write a Short note on :**

   a) Grievance Management

   _____

   _____

   _____

   b) Rights and duties of PwD at the workplace

   _____

   _____

   _____

   c) Gender based issues at workplace

   _____

   _____

   _____

   d) Best practices for gender sensitivity

   _____

   _____

   _____

   e) Best practices for gender sensitivity

   _____

   _____

   _____

2. **Match the following:**

Column A	Column B
Gender inequality	Gender-specific social groups
Listen attentively	Equal access to benefits
Rights at Workplace concerning PwD	With hearing disability person to get his attention
Tap a person on shoulder	Disparity in promotions
Do not promote	While talking with people having difficulty speaking

Notes

QR Code

Scan the QR Code to watch the related video

https://www.youtube.com/watch?v=QGHBq5OEsBM

Effective communication at workplace

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
National
Skill Development
Corporation
Transforming the skill landscape

10. Employability Skills

WATER MANAGEMENT AND PLUMBING SKILL COUNCIL

https://eskillindia.org/NewEmployability

DGT/VSQ/N0102

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
National
Skill Development
Corporation
Transforming the skill landscape

WATER MANAGEMENT AND PLUMBING SKILL COUNCIL

11. Annexure

Annexure - QR Codes

Annexure - QR Code

Serial No.	Module No.	Unit Number	Topic Name	Page No.	URL	QR Code
1.	Introduction to the sector and the job role	Unit 1.1 Plumbing Industry-An Introduction	Overview of the Plumbing Industry	14	https://youtu.be/Rfz1zVu8VaQ	
			Scope of Employment in the Contracting Segment		https://youtu.be/Fq7FIsuNCQI	
		Unit 1.2 - Water Flow Process	Plumbing Cycle		https://youtu.be/-bvZCdMecEo	
			Various Types of Plumbing Systems in Residential and Commercial Setups		https://youtu.be/8jxRn-T_LCs	
2.	Basics of Plumbing	Unit 2.1 Introduction to Plumbing	Process of Mains Supply of Water and Drainage	65	https://youtu.be/wpQD4XzjKDM	
		Unit 2.2 Plumbing Materials	Pipe Materials		https://youtu.be/1YQ9dpa6_lw	
			.Various Pipe Fit-Off Processes		https://youtu.be/q33WAVm0K5o	

Annexure - QR Code

Serial No.	Module No.	Unit Number	Topic Name	Page No.	URL	QR Code
		Unit 2.3 Plumbing Tools and Equipment	Different Types of Plumbing Tools and Equipment	65	https://youtu.be/GfNUaVFmxaY	
3.	Basic Tasks to Facilitate Plumbing Work	Unit 3.2 - Handling of Plumbing Materials	Safe use of Plumbing Tools	82	https://youtu.be/AI9YIy-86v8	
9.	Working Effectively With Others	Unit 9.1 - Work and Communicate Effectively at Workplace	Effective communication at workplace	247	https://www.youtube.com/watch?v=QGHBq5OEsBM	

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