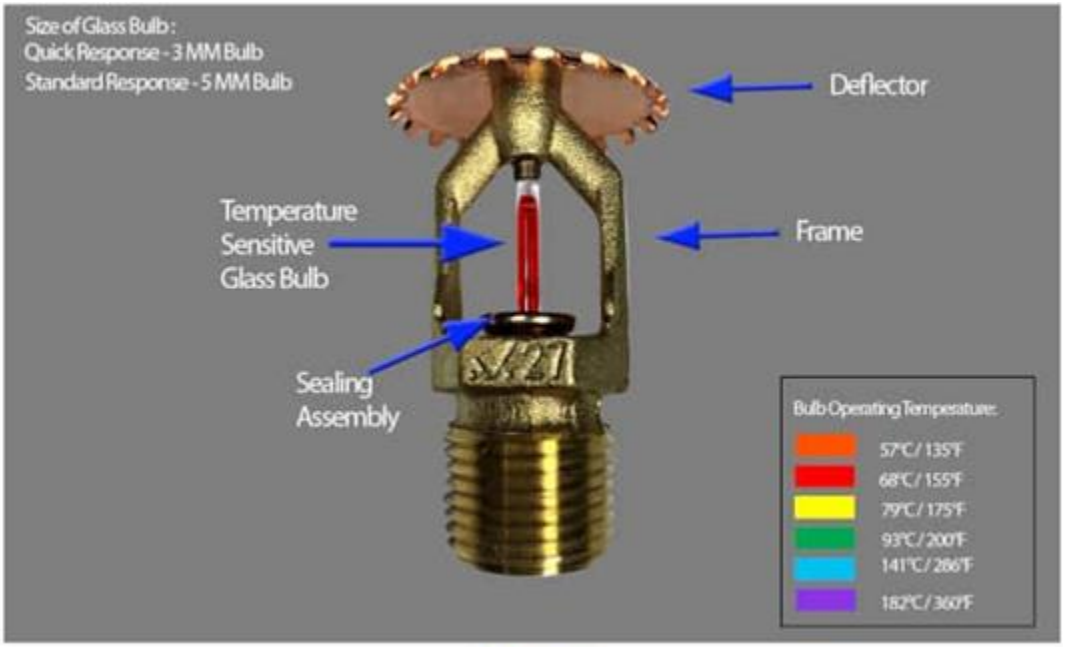
Plumbing Installation

Level-III

Based on October 2023, Curriculum Version 2



Module Title: - Installing, servicing and maintaining Residential Fire Protection Sprinklers

Module code: EIS PLI3 M08 1023

Nominal duration: 90 Hour

Prepared by: Ministry of Labor and Skill

October, 2023

Addis Ababa, Ethiopia

Table of Content

Acknowledgment

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

Acronym

PPE……....Personal Protective Equipments

GI …….. .Galvanized Iron

PPR …… Polypropylene Random Pipes

HPDE ……. High Density Polypropylene

UPVC ……. Uni Plasticized Polyvinyl Chloride

PVC …… Poly Vinyl Chloride

PE ……Polyethylene

SCBA……..Self-Contained Breathing Apparatus

NFPA …….National Fire Protection Association

EBCS ……. Ethiopian Building Codes and Standards

Introduction to the Module

In plumbing installation filed; knowing how to Install, Service and Maintien fire protection sprinkler Systems and Components helps to perform an accurate and resilient Installions, Service and Maintenance of fire protection sprinkler Systems and Components with in a given standards and spécification to satisfy Customer need and to do a battre job.

This module is designed to meet the industry requirement under the plumbing installation occupational standard, particularly for the unit of competency: **Install Service and maintain fire protection sprinkler Systems and Components.**

This module covers the units:

- Concept of Fire Protection Sprinklers
- Installation and routine maintenance requirements
- Installation of fire sprinkler System components

Learning Objective of the Module

At the end of this session, the trainees will able to:

- Plan and Prepare for work
- Identify installation and routine maintenance requirement
- Install, test and maintain fire sprinkler system components

Module Instruction

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

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

Unit one: Basic Concepts of Fire Protection Sprinklers installation.

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

- Introduction to fire protection sprinkler
- Plans and specifications.
- OHS requirements & work place environment.
- Quality assurance.
- Tools and equipments.
- work area. preparation

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

- know general concepts of fire protection sprinkler
- Adhere OHS requirements associated with fire protection.
- Understand quality assurance.
- Plan and sequence tasks.
- Know how to Selecting, checking tools and equipment.
- Perform preparing work area.

1.1. Introduction to fire and fire protection sprinkler system

Fire is triangle of: - oxygen, fuel and heat

Oxygen: It is a gas readily and abundantly available in the air. It cannot be drawn from the atmosphere because we, human beings, live due to taking a breath with the help of oxygen.

Fuel: The things that burn due to the fire are called the fuel of fire. the fire spread because of this fuel. If the fuel will be less the scale of fire will be lower and if the fuel will be more the scale of fire will be higher.

Heat (ignition source): Without an ignition source, the fire cannot be initiated. For example, we can turn on a stove with the help of a flame of match stick or an electric spark.

With the help of these three elements, a fire triangle completes and gives rise to a fire hazard. The heat produced with the ignition source starts burning the material called the fuel of the fire and oxygen present in the air, aids the fire to keep burning.

The fire safety equipment works on the following ways to extinguish the fire:

Cooling: In this method, we remove heat element from the fire. We can either cool the fire by throwing water, using a water type fire extinguisher or we can use foam type fire extinguishers.

Starvation: Starvation means lack of food, as we human beings grow by eating food similarly fire grows because of burning of fuel. If we remove fuel from the fire scene it will not be able to spread and will be extinguished.

Smothering: In this method we cut off the supply of oxygen. We can stop the supply of the oxygen from the fire triangle by using the following fire safety equipment like Co2 fire extinguishers, DCP fire extinguishers and fire blanket.

Chain breaking reaction: In this method, we use agents that interfere the chemical chain reaction i.e the products of combustion and heat is taken away through the agents of fire safety equipment. We can use DCP fire extinguishers or fire blankets.

Fire also have it as own stage that are listed below -

1. **Incipient stage**: - this stage is initial stage of fire and fire is easily controllable with extinguisher

2. **Growth stage**: - in this stage the fire will increase rapidly in large area Heat and gases produced by fire Sprinkler head would limit the fire growth fully developed stage: - also called flashover Near simultaneous ignition of all combustible material in an area

3. **Decay stage**: - in this stage all fuel of within the space has been burned. Typically charred structural members.

- **Class of fire and fire extinguishers**
  - **Class A fire**: A fire involving combustibles such as wood, paper, and other natural materials. In this fire we use water extinguisher for fighting the fire that are caused by wood, paper and other combustible material. The color fire extinguisher for class A fire green an the shape is triangle.
  - **Class B fire**: A fire involving hydrocarbons. The foam extinguisher used for the fire that becomes class A and class B. The color fire extinguisher for class B fire is red and shape of square.
  - **Class C fire**: An electrical fire. The color fire extinguisher for class C fire is blue and circle shape.
  - **Class D fire**: A fire involving metals, such as sodium, titanium, magnesium, potassium, uranium, lithium, plutonium and calcium. The color fire extinguisher for class D fire yellow and star shape.
  - **Class K fire**: A new classification of fire as of 1998 that involves fires in combustible cooking fuels such as vegetable or animal oils and fats. The color fire extinguishers for class K fire black and hexagon.

Fire Protection of a building refers to the building ability to detect, withstand, prevent and reduce any damage caused by a sudden unexpected fire whether man made or non-man made

Fire sprinkler systems: are networks of pipes, valves, and sprinkler heads strategically installed throughout a building. These systems are designed to detect and respond to fires automatically. Each sprinkler head is equipped with a heat-sensitive element. When the temperature nears a specific threshold to a fire, only the sprinkler closet to the fire source activates, releasing water to suppress the flames.

A fire sprinkler system is an active fire protection measure, consisting of a water supply system, providing adequate pressure and flow rate to a water distribution piping system, onto which fire sprinklers are connected.

Residential fire sprinkler systems provide powerful protection from fire. They work automatically and immediately, before a fire spreads.

1.1.1. Types of fire protection sprinkler system

Fire protection sprinklers are classified depending on two ways. Depending on utilization of piping and depending on nature of the risk

A. Types of sprinkler system depending on utilization of piping

Depending on utilization of piping There are two main types of residential sprinkler systems: stand-alone and multi-use.

Stand-alone systems: Although both systems rely on the home's water supply, a stand-alone system utilizes its own piping, and may need a back-flow device. Stand-alone systems will use flexible plastic or copper tubing. If a home relies on a well for water, a storage tank and pump will be necessary to ensure an adequate water supply for the system in the event of a fire. Storage tank size may vary depending on system size, and some codes require a minimum-sized tank. The water in stand-alone systems does not circulate, and might be susceptible to stagnation, depending on the piping used.

1. **Multi-use systems**: A multi-use sprinkler system shares the home's plumbing pipes; every time water is run anywhere in the home, fresh water moves through the pipes. This type of system ensures that in the event of a fire, non-stagnant water will be released. Multi-use systems are installed during new-home construction, and are engineered specifically for the home. Additions or remodels that seek to expand upon a multi-use sprinkler system can be quite difficult.

B. Types of sprinkler system depending on the nature of the risk

There are four different types of sprinkler system depending on the nature of the risk to be protected.

1. **Wet Pipe System**: all the pipe work is kept permanently full of water, right up to the sprinkler head. This type of system is standard in most buildings, and has the fastest response in terms of applying water to a fire. It should not be used in areas where there is a risk of freezing temperatures.
2. **Dry Pipe (Pre-action) System**: intended for use in cold stores or similar premises where the temperatures are maintained below or close to the freezing point of water. The pipe work is kept charged with compressed air to hold the water back below the control valve.

3. **Pre-action System**: used in areas where the consequences of accidental discharge, due to mechanical damage, are considered unacceptable, eg rooms containing electronic data processing or electrical equipment.
4. **Deluge Systems**: used to protect certain special risks, where there is a possibility that an intense fire will develop very rapidly, eg oil-filled transformer equipment. Deluge systems (sometimes also called "fogging" or "drencher" systems) are usually used to protect relatively small, external risks.

1.1.2. Obtaining plans

Plans are drawn to accurately describe a particular object or building to all interested parties before it is constructed. On large construction jobs, very detailed plans are needed. In the off-site construction industry where you may be working to produce plan from:

- Shop fittings
- Pre-fabricated housing components
- Headstones
- Signs
- Plans may be less detailed.

The plans are not as detailed. They still give information such as:

- What you are making, including sizes and design
- Where to install the product, if required
- How to install the product
- The location and size of the spaces in the building
- The materials that are to be used
- The location of the building on the site
- Special fittings and finishes
- In some cases the layout of services eg. Power and gas

Planning consideration

The design process has several important elements which are important to evaluate and quantify during the different project phases.

- Risk analysis
- Firewater demand
- Firewater hydraulic calculations

- Firewater supply
- Installation and mechanical completion
- Commissioning and testing of the firewater system

1.1.3. Obtaining Specification

Specifications for fire sprinkler systems are the written descriptions of the needs, desires, and concerns of the building owner with respect to the use of its building and how the sprinkler system needs to perform.

A sprinkler system designer requires a specification to design the system; consultation with stakeholders should take place to develop and produce the specification for the designer.

The specification for the design should include the following information:

A. Occupancy type for sprinkler protected area;
B. Any information regarding water supplies;
C. How sprinkler system alarms interact with fire alarm system;
D. Details of any enhancements to sprinkler system; and
E. Copy of fire strategy when a fire strategy has been produced;

1.2. Safety requirements and environmental protection

Fire safety concepts are defined as optimal packages of integrated structural, technical and organizational fire precaution measures which allow well defined objectives agreed by the owner, the fire authority and the designer to be fulfilled.

Fire safety in buildings is concerned with achieving two fundamental objectives:

1. To reduce the loss of life in, or in the neighborhood of, building fires.
2. To reduce the property or financial loss in, or in the neighborhood of, building fires.

A structural concept comprises compartmentation combined with an adequate fire resistant structure; it may be the best choice as long as the normal (cold-design) use of the building allows compartmentation by fire resistant floors and walls.

It is admitted that the fire may reach flashover conditions before fire fighting action begins.

The necessary time of fire resistance should be determined by the condition that the fire should not spread outside the fire compartment. Hence the separating and (possibly) load-bearing function of the relevant building components should be maintained during the anticipated duration of the fire.

Whenever possible fire spread should be limited by fireproof partition walls and floors. Combustible building components should be designed or treated to prevent fire spread by

smoldering, eg. in two layer built-up roofs the combustible layer should be covered by a non-combustible one. The design of the facade should prevent flames climbing into an upper storey.

It is important to underline that all partition elements like walls, decks, ceilings and roofs (in some cases) must fulfil three criteria to be classified in a fire class (30/60/90...).

- A load bearing criteria proving the stability of the element.
- Insulation criteria proving the insulation capacity of the element.
- An integrity criteria proving that no flames and no smoke goes through the element.

The load bearing structural elements with no partitioning function only have to fulfill the first criteria.

Fire resistance of the building components is usually prescribed in the building codes where it is normally expressed in units of time.

The required time for fire resistance is usually expressed in terms of multiples of 30 minutes: for example 30, 60, 90 minutes, related to ISO Standard fire. This means that a component is able to fulfill its function during the required time under a temperature exposure according to ISO.

It is most applicable for occupancies with reduced fire load densities, for low to medium-rise buildings in which fires may be expected to develop slowly and where an effective and quick-responding fire brigade is available.

1.2.1. Codes, Legislations and regulations of OHS on fire protection

Governments and organizations worldwide have developed fire safety codes and regulations to ensure a secure environment.

Fire safety codes are comprehensive guidelines and standards that establish minimum requirements for fire protection in buildings and industrial facilities. They are developed based on extensive research, data analysis, and best practices in fire prevention and suppression. Compliance with fire safety codes is crucial for preventing and mitigating fire incidents, ensuring the safety of occupants, firefighters, and the general public. By adhering to these codes, a safer environment can be created, reducing the risks associated with fire emergencies.

Let see the three significant fire safety codes as examples: the National Fire Protection Association (NFPA) codes, and the National Building Code of India (NBC). While there is various renowned fire safety codes implemented globally, this article aims to delve into the importance and significance of these three codes specifically.\

National Fire Protection Association (NFPA) Codes:

The National Fire Protection Association (NFPA) is a globally recognized organization that develops and publishes fire safety codes and standards. NFPA codes cover various aspects of fire safety and are widely adopted worldwide. Here are some key NFPA codes:

A. **NFPA 101: Life Safety Code:** This code provides requirements for building design, construction, operation, and maintenance to ensure the safety of occupants in case of fire or other emergencies. It includes provisions for means of egress, fire protection systems, occupancy classification, and emergency lighting.

B. **NFPA 13: Standard for the Installation of Sprinkler Systems:** This code specifies the design, installation, and maintenance requirements for automatic sprinkler systems. It covers the placement of sprinklers, water supply, pipe sizing, and other technical aspects to effectively suppress fires.

C. **NFPA 72: National Fire Alarm and Signaling Code:** This code sets the standards for fire alarm systems, including their design, installation, testing, and maintenance. It covers various types of fire alarm systems, such as smoke detectors, heat detectors, and emergency communication systems.

D. **NFPA 70: National Electrical Code (NEC):** While not specific to fire safety, the NEC provides guidelines for safe electrical installations, which play a crucial role in fire prevention. It covers wiring methods, equipment grounding, overcurrent protection, and electrical system design to mitigate fire risks caused by electrical faults.

Codes are continuously updated to incorporate new research, technology advancements, and lessons learned from fire incidents. They serve as a comprehensive resource for fire safety professionals, engineers, architects, and authorities having jurisdiction.

Ethiopian codes and regulations of OHS on fire protection

The EBCS 13 was developed by the Ministry of Construction and Urban Development (MoUDaC) and prepared by under the Consultancy services of Addis Ababa Institute of Technology (AAIT) of the Addis Ababa University using a Technical Committee reference No. MUDC/AAIT/EBCS 13/2012-13. The document reference issue No is: - **EBCS 13/001/2012-13**

The Title of this Code is "**EBCS 13: Fire precautions during Building Construction Design Services, Works and Uses**" as part of the other Ethiopian Building Codes of Standards.

The purpose of this code is to provide minimum requirements developers, designers, contractors and professionals to respect during building construction design services, works and uses.

According to **EBCS 13 section 2.2.4** The following fire safety requirements are available for use and are recommended in this code during fire protection systems design, services, works and uses:

1. Planning and protection of alternative exits and escape routes from rooms and buildings at all times.
2. Defining restrictive or maximum travel distances.
3. Selective positioning of rooms within buildings and segregation of high fire risk or hazard areas.
4. Provisions of automatic (where appropriate) fire, smoke, flame and heat warning or detection, alarm and control systems or installations or equipment to maintain the effectiveness of exits and escape routes.
5. Provisions of self-closing fire doors where appropriate.
6. Provisions of structural fire barriers within and between buildings and as separation to circulation spaces when serving as escape routes.
7. Provisions of automatic (where appropriate) firefighting or extinguishing systems to limit growth of fires and to assist firefighters.
8. Construction with appropriate fire resistant components of buildings and building materials.
9. Provision of appropriate and sufficient access for firefighters to buildings when fire arises.
10. Timely notifying or informing or alarming occupants and fire brigades when ignition or potential cause for fire is observed.

1.2.2. Safety equipment for fire protection work

Fire safety equipment is save the environment from huge losses and pollution caused by fire. Fire is a hazardous incident, which if takes place may cause an irrecoverable loss. The fire outbreak can damage living as well as non-living things.

The fire can easily burn the houses, shops, schools, offices hospitals, and other buildings, and the persons present inside the buildings, and in the surroundings of those buildings.

1.2.2.1. Types of fire safety equipments

There are many different types of fire safety equipment. Each device is designed specifically to deal with the different classes of fire in a range of environments. If you're struggling to figure out which fire safety devices you need in your building, take a look at the following range of equipment.

Once you have an idea of the fire safety measures in your building,

1. Fire Extinguishers

Most buildings contain a variety of hand-held firefighting equipment. This range of equipment is designed to help contain small fires before they spread and become too large to control. Portable fire extinguishers are available with a number of different extinguishing agents to help you combat a flame. A portable extinguisher may contain the following substance:

- water
- foam
- dry powder
- CO2
- wet chemical

fig. extinguisher

2. Fire Blankets

Fire blankets are designed to smother class F fires. That means flame that is fuelled by cooking oils and fats. Naturally, fire blankets are installed in kitchen environments, where the chance of a class F fire is the highest.

3. Fire Hose Reels

Fire hose reels are ideal for extinguishing class A fires. That is fires that are fuelled by paper, rubber, wood, and other non-conductive materials. As fire hose reels discharge water, they cannot be used to combat electrical fires. There are other types of fire safety equipment designed to deal with electrical fires – namely C02 fire extinguishers.

fig. hose reel

4. Signage

All fire equipment should be accompanied by standard signage. This helps users identify the location and type of equipment they can access in an emergency. There is a range of different regulations when it comes to fire safety signage.

fig. signage

5. **Sprinklers**

Sprinkler is a device which install on buildings to protect from fire accidents, hazards and losses. Fire sprinkler systems are a network of pipes, valves, and sprinkler heads strategically installed throughout a building


fig. sprinkler

6. **First Aid Kits**

They might not be the first thing to spring to mind when you think of the different types of fire safety equipment, but first aid kits are essential in the aftermath of a fire. Having adequate first aid measures on hand will help with minor injuries sustained during a fire. It's also a matter of compliance – as a business owner or manager; you need to provide your staff members with first aid.

7. **Emergency & Exit Signs**

Whilst firefighting equipment is important during an emergency when a flame is out of control, you need to evacuate a building. Emergency and exit signs will help to provide a clear path to an exit during a fire. Having clear signage and lighting will help contain panic and guide your team members to an appropriate exit in time. Emergency and exit lights need to be maintained according to standard for Emergency escape lighting and exit signs.

8. **Smoke Alarms**

Some types of fire safety equipment are designed for detection. Smoke alarms should be installed in all commercial and domestic buildings. If you are a landlord, the legislation for smoke alarm installation varies from state to state. You can find more information about your obligations on your state government website.

1.2.2.2. personal safety equipment for fire protection work

Safe operation requires use of proper approved personal protective equipment (PPE) those are mentioned as follows:-

- Helmet
- Firefighting hood
- Eye protection
- Face shield
- Firefighting gloves
- Turnout coats
- Bunker pants
- Boots
- Self-contained breathing apparatus (SCBA)
- Personal alert safety system

1.3. Quality assurance requirements

All fire protection sprinkler installation work shall conform to the requirements of the applicable portions of the national fire protection association (NFPA) standards and other guidelines or standards listed herein:

1. Ethiopian Building Code and Standards (EBCS 13)**:**
2. International Building Code - 2012 Edition.
3. International Fire Code - 2012 Edition as.
4. NFPA 13 2010 Edition - Standard for the Installation of Sprinkler Systems
5. NFPA 14 2010 Edition - Standard for the Installation of Standpipe and Hose Systems

All work and materials shall conform to all International, Federal, and local codes and regulations governing the installation.

Code Conflicts: Should conflicts exist between the referenced NFPA Standards, Federal, State or local codes and this specification, it shall be Contractor's responsibility to bring the conflict to the attention of Owner for resolution. The contractor shall not attempt to resolve code conflicts with the local authority, independent of Owner. In general, in the event of a conflict, the most stringent of the requirements will apply.

Permit Fees: Contractor shall be responsible for filing all documents, paying all fees and securing all permits, inspections and approvals necessary for completing the scope of the work.

Equipment: All devices, systems, equipment and materials furnished and installed shall be new and shall be submitted for approval by Owner. All sprinklers, pipe, fittings, hangers, valves, and other materials and equipment shall be UL Listed and/or FM approved for their intended use. All shall be acceptable to the codes and standards when such agencies have listings of acceptable equipment.

Fittings: Fittings may be of the flanged, threaded, or grooved type. Welded outlets on cross-mains for riser nipples and/or branch lines, and for sprinkler outlets on branch lines will be permitted. All shall be UL Listed and/or FM approved for their intended use. The use of plain-end fittings to join steel pipe is not permitted.

1.4. Plan and sequence tasks

The process of fire protecting usually involves a sequence of steps or stages. Each phase of a fire-ground operation may require the use of certain types of tools and equipment.

The basic steps of fire suppression include:

- **Response/size-up:** This phase begins when the emergency call is received and continues as the units travel to the incident scene. The last part of this phase involves the initial observation and evaluation of factors used to determine the strategy and tactics that will be used.
- **Forcible entry:** This phase applies when entry to buildings, vehicles, aircraft, or other confined areas are locked or blocked, requiring fire fighters to use special techniques to gain access.
- **Interior attack:** During this phase, a team of fire fighters is assigned to enter a structure and attempt fire suppression.
- **Search and rescue:** As its name suggests, this phase involves a search for any victims trapped by the fire and their rescue from the building.
- **Rapid intervention:** A rapid intervention company/crew (RIC) is a team of fully equipped personnel that is designated to provide immediate assistance to injured or trapped fire fighters.
- **Ventilation:** This step involves changing air within a compartment by natural or mechanical means.
- **Overhaul:** The final phase is to ensure that all hidden fires are extinguished after the main fire has been suppressed.

1.5. Tools and equipments

Hand tools are used to extend or multiply body actions and increase the effectiveness in performing specific functions. Hand tool operation uses simple machine principles. Pike pole extends reach and allows ceiling penetration and pull down. Axe multiplies the cutting force

exerted on a given area. Power tools and equipment use an external power source, such as electric motors or an internal combustion engine, and are faster and more efficient than hand tools.

Most of the tools used by fire departments fit into the following functional categories: Rotating (assembly or disassembly), Pushing or pulling, Prying or spreading, Striking, cutting and multiple uses

- **Rotating Tools**

Rotating Tools Rotating tools apply a rotational force to make something turn.

The most common rotating tools are:

- Screwdrivers
- Wrenches
- Pliers

Used to assemble (fit together) or disassemble (take apart) parts that are connected with threaded fasteners Assembling and disassembling are basic mechanical skills that are routinely used by fire fighters to solve problems.

Additionally Common Rotating Tools

- Rotating tools Box-end wrenches
- Gripping pliers
- Hydrant wrenches
- Open-end wrenches
- Pipe wrenches
- Screwdrivers
- Socket wrenches
- Spanner wrenches

Fig. Rotating tools

- **Pushing/Pulling Tools**

Pushing/Pulling Tools Pushing/pulling tools can extend the reach of the fire fighter and increase the power that can be exerted on an object. These tools have many different uses in fire department operations

Pike Pole

An example of a tool that extends reach is a pike pole. A pike pole consists of a wood or fiberglass pole with a metal head attached to one end. A pike pole is used primarily to pull down a ceiling to get to the seat of a fire burning above. The metal head has a sharpened point that can be punched through the ceiling and a hook that can grab and pull it down.

Pike poles come in several different sizes and with a variety of heads. The most common length of 4 to 6 ft enables a fire fighter to stand on a floor and pull down a 10-ft high ceiling. Closet hooks, intended for use in tight spaces, are commonly 2 to 4 ft long. Some pike poles are equipped with handles as long as 12 or 14 ft for use in rooms with very high ceilings; others may have a D-type handle for better pulling power. Bring the right size pike pole to a fire.

The different head designs are intended for different types of ceilings and come in a variety of configurations. Many fire departments use one type of pike pole for plaster ceilings and another for drywall ceilings.

Fig. pushing and pulling tools

Prying/Spreading Tools

Prying/Spreading Tools These tools may be as simple as a pry bar or as mechanically complex as a hydraulic spreader. They also come in several variations for different applications. A simple pry bar consists of a hardened steel rod with a tapered end that can be inserted into a small area. The bar acts as a lever to multiply the force that a person can exert to bend or pry objects apart. A properly positioned pry bar can apply an enormous amount of force. This tool incorporates a sharp pick, a flat prying surface, and a forked claw. It can be used for forcible entry applications

Common Prying/Spreading Tools are:

- Claw bar
- Crowbar
- Flat bar
- Halligan tool
- Hux bar
- Kelly tool

- Pry bar

A K- tool is another type of pushing or pulling tool. This tool is used to pull the lock cylinder out of a door, exposing the locking mechanism so it can be unlocked easily.

Fig. prying and spreading tools

Striking Tools

Striking tools are used to apply an impact force to an object. They are often used to gain entrance to a building or a vehicle or to make an opening in a wall or roof. They can also be used to force the end of a prying tool into a small opening.

Common Striking Tools

- Hammer
- Mallet
- Sledgehammer
- Maul
- Chisel
- Flat-head axe
- Pick-head axe

One of the most frequently used tools in the fire service is the axe. Both flat-head axes and pick-head axes are used.

Fig. striking tools

Cutting tools

Cutting tools have a sharp edged that serves an object. They come in several forms and are used to cut a wide variety of substances. Cutting tools used for fire protect range from knives or wire

cutters carried in the pockets of turn out coats to seatbelt cutter. Bolt cutters (a scissors lick tools used to cut through items such as chain or padlocks) saws, cutting torches (a torch that produce a high temperature flame capable of melting through metal) and hydraulic shears.

Each is designed to work on certain type of materials. Fire fighters can be injured and cutting tools can be ruined if tools are used incorrectly.

Common cutting tools are mentioned as follows:

- Axes
- Bolt cutters
- Chain saws
- Cutting torches
- Hack saws
- Hand saws
- Hydraulic shears
- Reciprocating saws
- Rotary saws
- Seatbelt cutter

Fig. cutting tools

<u>Hack saw</u>- It is a tool used to cut pipes and other metals

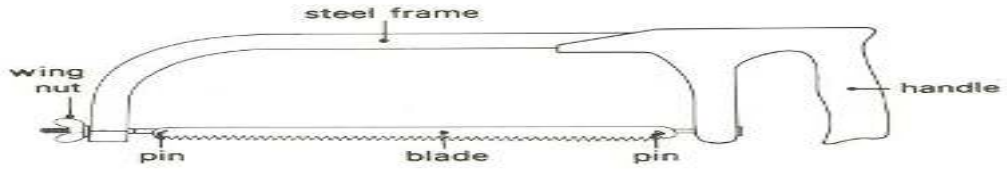


Fig. Hack saw

<u>Pipe cutter</u>: - It is used to cut pipes at right

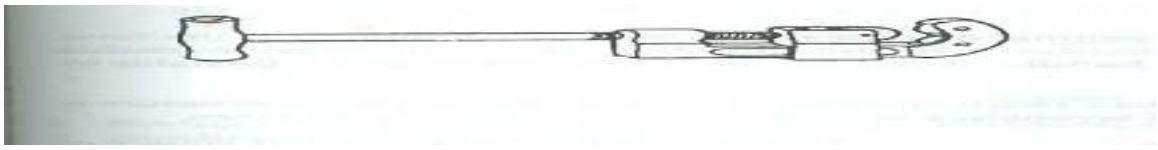


Fig. Pipe cutter

Bending tools: - They are used to bend pipes at the required angles.

Hydraulic pipe bender

Fig. Bending tools

Drilling machine - to make or drill hole in the concrete. Drilling machine is depending up on the material to be drill, i.e. the drill bit.

Fig. Drilling machine

1.5.1. Select and operate tools and equipments

Requirements of inspecting and selecting Tools and Equipment

- Test the performance and use undamaged.
- Guards should be securely in place.
- Clean and inspect hydraulic hoses.
- Inspect power cords for damage.
- Clean, inspect, and test hose fittings.
- Start tools to ensure correct operation.
- Empty, wash, clean, and dry tanks on water vacuums.

- Clean and dry hoses and nozzles on water vacuums.
- Read and follow all manufacturer-provided manuals.
- Refer to manuals when cleaning and inspecting.
- Learn proper procedure for reporting a problem with power tools and taking it out of service.

1.6. Preparation of work area

The following requirements should be followed by people who perform installation of fire protection sprinkler activities in order to maintain safe work place.

A. Sprinklers shall not be required in bathrooms where the bathroom area does not exceed 5.1 m^2.

B. Except where specified in C, sprinklers shall not be required in clothes closets, linen closets, and pantries within dwelling units that meet all of the following conditions:

(1) The area of the space does not exceed (2.2 m^2).

(2) The least dimension does not exceed (0.91 m).

(3) The walls and ceilings are surfaced with noncombustible or limited combustible Copyright NFPA materials as defined by NFPA 220, Standard on Types of Building Construction.

C. Sprinklers shall be installed in any closet used for heating and air conditioning equipment.

D. Sprinklers shall not be required in any porches, balconies, corridors, and stairs that are open and attached.

E. Sprinklers shall not be required in attics, penthouse equipment rooms, elevator machine rooms, concealed spaces dedicated exclusively to and containing only dwelling unit ventilation equipment, crawl spaces, floor/ceiling spaces, noncombustible elevator shafts where the elevator cars comply with ANSI A17.1, Safety Code for Elevators and Escalators, and other concealed spaces that are not used or intended for living purposes or storage and do not contain fuel fired equipment.

F. Sprinklers shall not be required in closets on exterior balconies, regardless of size, as long as there are no doors or unprotected penetrations from the closet directly into the dwelling unit.

Procedures for Preparing Work areas

1. All excess material should not be wasted, but used or safely removed from site according to appropriate legislation.

2. Identify the waste types that are likely to be produced and aim to reduce the amount of waste as much as possible, through identifying routes to reuse or recycle materials.
3. Control access to storage areas to minimize risk of theft or damage.
4. Store any materials away from sensitive locations in fenced off areas.
5. Label all waste storage and skips, detailing the type of waste.
6. Employ a just-in-time policy to deliver materials in order to reduce the storage time on site.
7. Safety at all times should be positive. You must know what to do, what to use, what to prevent & what guards in the work area.
8. Keep work area free from unnecessary item, that cause slipping hazards

Self-check-1

Instruction: Write True or False for the given questions. You have given 1 Minute for each

Occupancy type for sprinkler protected area is one of the information included in specification

1. Safety requirements are used to protect loss of life but not property
2. Fire extinguisher is portable equipment
3. Fire blankets are designed to protect class A fire
4. Screw driver is type of pushing/pulling tools

Instruction II: select the correct answer for the give choice. You have given 1 Minute for each question.

1. At which stage of fire it will increase rapidly in large area
   - A. Incipient stage
   - B. Growth stage
   - C. Decay stage
   - D. None of the above
2. Type of sprinkler system which categorized based on utilization of piping
   - A. Stand alone system
   - B. Wet pipe system
   - C. Pre action system
   - D. Deluge system
3. Which one of the following is not included in planning consideration
   - A. Risk analysis
   - B. Fire water demand
   - C. Fire water hydraulic calculation
   - D. None of the above
4. National fire protection association quote about Standard for the Installation of Sprinkler Systems at
   - A. NFPA 101
   - B. NFPA 13
   - C. NFPA 72
   - D. NFPA 70
5. Which type of fire safety equipment designed for class F fires
   - A. Fire extinguisher
   - B. Fire blanket
   - C. Fire hose reel
   - D. All of the above

Instruction III: write short answer for the given question. You are provided 3 minute for each question and each question has

1. List at least three PPE used in fire protection sprinkler installation work
2. What are the components of fire triangle
3. Write down at least three hand tools and power tools used in fire protection sprinkler installation work?

Unit Two: Installation and routine maintenance requirements.

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

- System requirements
- Materials, of sprinkler system
- Maintenance task and schedule
- Mechanical equipments and system components
- Faulty items or components identification

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

- Understand system requirements
- Identify materials for sprinkler system
- Perform maintenance of sprinkler components
- Identify faulty items or components

2.1. Requirements of sprinkler System installation

Residential sprinkler installation spacing and positioning should be in accordance with the following requirements:

A. The maximum area protected by each sprinkler should be in accordance with its approved listing performance or 25 m², whichever is the lesser.
B. Sprinklers should be not more than 5.5 m apart or more than half the design spacing from any wall or partition.
C. The distance between sprinklers within a compartment should be not less than 2.4 m, except where there is an intervening constructional feature preventing adjacent sprinklers wetting each other.
D. Pendent and upright sprinklers should have heat-sensitive elements, not more than 100 mm below the ceiling and under no circumstances exceeding the manufacturer's approval listing, whichever is the lesser.
E. Sidewall pattern sprinklers should have the top of the deflector within 100 mm to 300 mm below the ceiling and under no circumstances exceeding the manufacturer's approval listing, whichever is the lesser.
F. The whole of the floor area and the walls from the floor up to 0.7 m below the ceiling should be wetted when the sprinklers are operated.
G. For sloping ceilings, sprinklers should be positioned in accordance with the manufacturer's instructions.
H. Sprinklers should be positioned such that the sensitivity and discharge pattern are not adversely affected by obstructions, such as constructional beams, smoke alarms, light fittings or other sprinkler heads (refer to manufacturer's instructions for guidance).
I. Sprinklers should be positioned a sufficient distance from any heat sources (e.g. fireplaces, stoves, ovens, kitchen ranges, hot air flues, hot water pipes, hot air diffusers, water heaters, heat generating light fixtures) in accordance with the sprinkler head manufacturer's instructions.
J. The potential for a shielded fire to develop should be taken into account.
K. Sprinklers should be not less than 100 mm or the manufacturer's recommended distance, whichever is greater, from any wall or partition.

2.2. Material and component of sprinkler system

Residential sprinkler systems consist of certain amount of components those are a water supply, backflow prevention device (e.g. check valve), stop valve, priority demand valve (where required), automatic alarm system and pipe work to sprinkler heads.

The sprinklers are fitted at specified locations, the appropriate sprinkler type being used for each location.

Some components of sprinkler systems are mentioned in detail as follows:

1. **Stop Valve**: The Stop Valve is used to isolate the water supply; it may also be called the isolating valve. It is often painted RED in color with a large black circular handle, and is locked in the OPEN position, allowing the free flow of water. The stop valve is used to isolate (stop) the water supply coming into the fire sprinkler system. Often the Stop Valve is also fitted with a Valve Monitoring Device ("Valve Monitor"

Fig. Stop valve

2. **Valve Monitor**: That is used to monitor the state (open or closed) of the Stop Valve. The water within an automatic fire sprinkler system can be divided into two parts;
    a. Water Supply or Mains: This is the water being fed into an automatic fire sprinkler system from a water supply such as the town mains or a static water supply such as a tank, up to the Stop Valve;
    b. Installation The water after the stop valve forms part of the installation.

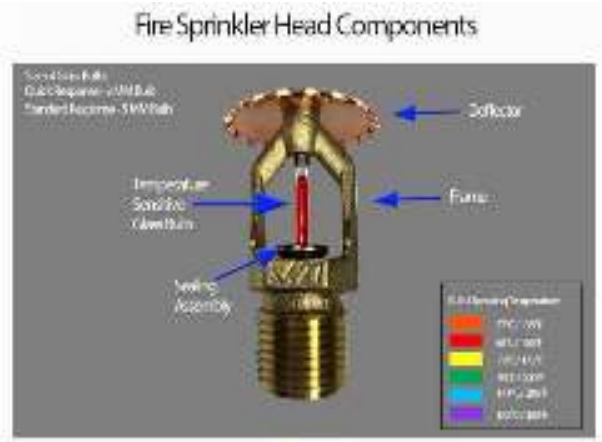
fig. valve monitor

3. **Alarm Valve**: The Alarm Valve (also known as an 'alarm check valve') is used to control the flow of water into the fire sprinkler system. This is accomplished by providing a one way (check) valve that is closed when the water pressure on the fire sprinkler side of the valve exceeds the water supply pressure. When the pressure equalizes or falls below the water supply pressure, the valve opens to enable water flow. The alarm valve should, (if routinely

serviced), help maintain the water pressure within the automatic fire sprinkler system, helping to reduce the possibility of false alarms.

fig. check valva

4. **Automatic Fire Sprinkler Head**: The fire sprinkler head is also used to control the flow of water. It is essentially a valve that when exposed for a sufficient time to a temperature at or above the temperature rating of the heat sensitive element (glass bulb or fusible link) releases, allowing water to flow from only the affected sprinkler. The operation and subsequent water flow of an automatic fire sprinkler will lead to a drop in pressure within the fire sprinkler system after the alarm valve.



5. **Alarm Test Valve**: The alarm test valve is a small valve, normally secured in the closed position. The alarm test valve is fitted between the sprinkler system side of the alarm valve and the drain. The purpose of the alarm valve is when opened to simulate the flow of water from a single automatic fire sprinkler.
6. **Motorized Alarm Bell or Gong**: is a mechanical device, operated by the flow of water oscillating a hammer that strikes a gong, causing an audible alarm signal.

fig. alarm bell

7. **Pipes:** Fire pipes are specially designed pipes that are used to transport water or other extinguishing agents in the event of a fire. They are made from high-quality materials that are sturdy and resistant to corrosion.

Steel pipe is heavy and usually requires special equipment to move around a job site. That also means two or more installers working in the same area.

CPVC pipe and fittings weigh significantly less than steel, but installation too is faster, saving labor.

Firefighting steel pipes are thicker and stronger than regular pipes, which makes them better suited for handling high-pressure water flow. Firefighting pipes are a vital tool in ensuring the safety of both the firefighters and the general public during a fire. They are designed and manufactured with the strictest safety standards in mind, and they undergo rigorous testing to ensure that they can withstand the extreme conditions of a fire.

The main materials of fire pipes are mentioned as follows:

- Carbon steel
- Ductile iron
- Stainless steel
- Alloy steel
- Composite or plastic pipe
- Galvanized pipe

Let seen some types of pipes:

Fig. Black steel pipes

Fig. Galvanized steel pipes

Fig. CPVC pipes

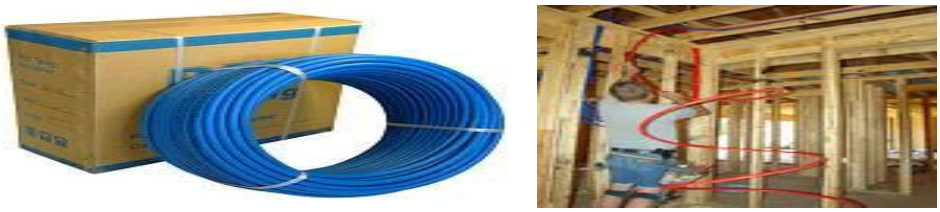


Fig. PEX pipes

- **Sprinkler Head Components**

The typical sprinkler consists of a frame, thermal operated linkage, cap, orifice, and deflector Styles of each component may vary but the basic principles of each remain the same.

Types of Sprinkler Heads based on position listed as follows:

Fig. sprinkler head components

Pendants: Most common head Extends down from a ceiling Sprinkler sprays a stream downward onto a deflector.

Uprights: Sits on top of the piping Sprays water up towards the deflector cannot be used as a pendant.

Sidewalls: Comes out of a wall to protect hallways or small rooms has a fan shaped deflector Used in Hallways or special areas that are not big enough for regular heads.

2.2.1. Calculation of materials quantity

A bill of quantities is a document used in tendering in the construction industry in which materials, parts, and labor are itemized. It also details the terms and conditions of the construction or repair contract and itemizes all work to enable a contractor to price the work for which he or she is bidding.

While a bill of quantities (BOQ) includes an itemized list of all project costs including materials and labor hours a bill of materials (BOM) only includes materials. BOM can be including in the bid packages for subcontractors, on large and small projects alike. Just like a BOQ, a bill of materials helps to simplify bid comparison from multiple contractors.

BOM (Bill of Material) consists of the list of parts, raw/sub materials and their quantity required to produce a finished good.

When there are multiple BOM (Bill of Material) for a specific finished/semi-finished good, manage them by multiple BOM (Bill of Material) versions.

Detailed estimation of material quantity

A detailed estimate is prepared for technical approves, administrative approval and also for execution of a contracts with a contractor.

Factors to be considered during preparation of a detailed estimation of material are:

- Quantity of materials.
- Availability of material
- Transportation of material
- Location of site
- Local labour market

Steps in Preparation of an Estimate quantity:

There are three clearly defined steps in the preparation of an estimate.

1. Taking out quantities*:* in the first step of taking out quantities, the measurements are taken off from the drawings and entered on measurement sheet or dimension paper. The measurements to be taken out would depend upon the unit of measurement. For example, in the case of stone

masonry in superstructure, length, thickness and height of the walls above plinth level would be taken out from the drawings and entered on the measurement sheet, whereas, in the case of plastering only the lengths and heights of the walls would be entered. Obviously, the unit of measurement in the first case is cubic meter and that in the second case is square meter.

2. Squaring out: The second step consists of working out volumes, areas, etc. and casting up their total in recognized units.

3.Abstracting (working up): In the third step all the items along with the net results obtained in the second step are transferred from measurement sheets to specially ruled sheets having rate column ready for pricing.

The second and third steps above are known as working up. All calculations in these stages and every entry transferred should be checked by another person to ensure that no mathematical or copying error occurs

Setting down of dimension

Measurement of materials refers to the taking off dimensions by directly reading from the (drawing) plan or by scale measurements (when ever measurements are not given).

The amount of work measured is called quantity.

Form of dimension:-before going any further it is necessary to understand the dimension as set down by the take of all dimensions. The measurement of quantities deals with:

- Measuring of length (linear measurement) , length=m
- Calculation of areas, **length x width=m^2**
- Calculation of volumes or **length x width x depth =m^3**
- Counting the number of pieces depending up on the nature of work and items used.

Basic Principles in material Quantity

1. Drawings shall be fully understood clearly and detailed.
2. During discrepancies in detailing, dimensioning or if missing from the designer.
3. The BOQ shall accurately represent the works to be executed.
4. Works, which cannot be measured accurately, shall be expressed as provisional quantity (PQ) and will result in provisional sum (PS) and lump sum (LS).
5. Prepared in such a way that discrepancies or mistakes in taking off will not result in excessive variation in the project cost which directly affect the budget allocation for the project.
6. With the understanding that measurements are taken to the nearest cm.

7. Built items shall generally include all possible entrants which will make labor, materials (including storing, loading, unloading and handling), fixing, use of plant and equipment, wastage of materials, equipment establishing charges and profit; otherwise it shall be stated specifically.
8. With the understanding that there is a standard paper format to carry out measurements of civil works, namely take off sheet or dimension paper, bending schedule and specification worksheet.
9. Prior knowledge of the regulations is necessary
10. Measurements of civil works shall be carried out in such a way that it can be easily checked and audited.

Material quantity of fire sprinkler installation works

All the items or parts mentioned in relevant clauses of the specifications and BOQ shall be consider being included in the quoted rates, unless specifically excluded.

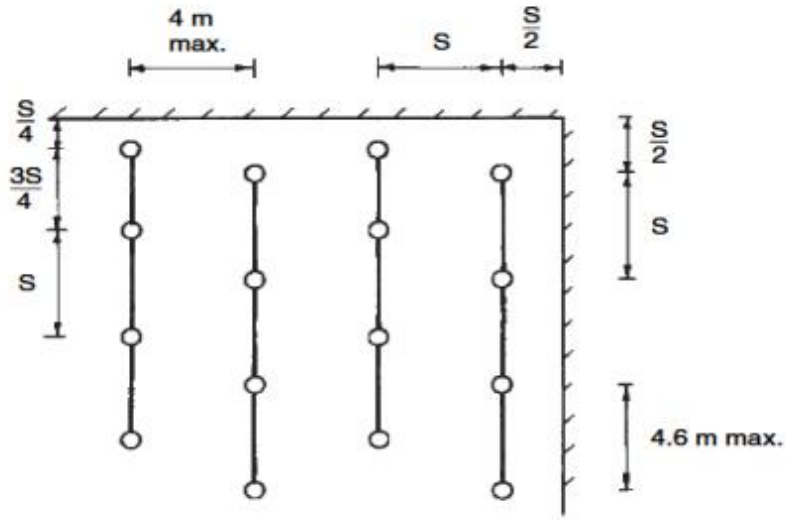
Providing and fixing horizontal Fire Pumping Set with CI body, Bronze Impeller, Stainless Steel Shaft and connected by a flexible coupling to a totally enclosed, fan cooled induction motor, mounted on common structural base plate with all pump accessories complete as per Specifications including mechanical seal & neoprene lined vibration eliminators. Motors shall be suitable for 415 volts, 3 phase, 50 cycles, A/C supply Installation, testing and commissioning as per Specifications with all fittings. Thos and others all components and accessories should quantified.

Pipes are measured in linear meters over all fittings and branches, stating the type, nominal size and the method of jointing and fixing. Fittings are enumerated and measured as extra-over the pipe work on which they occur.

In a domestic situation this will include such things as extinguishers, pumps, alarms, valves and such type material are enumerated giving in the description the type, size, pattern, rated duty, capacity and method of fixing.

Further Pipework Distribution and Spacing Calculations

Staggered arrangement of sprinkler heads on an ordinary hazard installation:



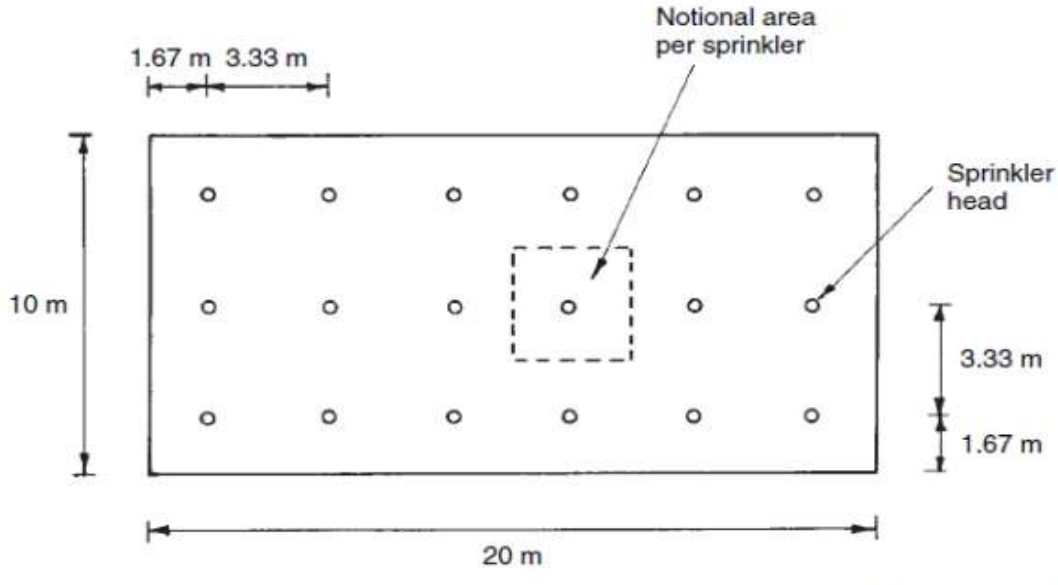
Calculating the number of sprinkler heads: e.g. an ordinary fire hazard category for a factory having a floor area 20 m × 10 m.

$$20 \times 10 = 200 \text{ m}^2$$

Ordinary hazard requires a maximum served floor area of 12 m² per sprinkler head.

Therefore: 200 ÷ 12 = 16·67, i.e. at least 17 sprinkler heads.

For practical purposes, 18 could be installed as shown:



The maximum area served by each sprinkler head = 3·33 m × 3·33 m = 11·1 m².

This is satisfactory, being less than 12 m².

Sprinkler pipe installations downstream of the alarm and control valves should be sized by hydraulic calculation, with regard to system pressure and friction losses. Tabulated data for pipe sizing is available in BS EN 12845 and CIBSE Guide E : Fire engineering.

It is also possible to determine pipe diameters from the Hazen-Williams friction loss formula:

$$p = \frac{6{\cdot}05 \times 10^5 \times L \times Q^{1{\cdot}85}}{C^{1{\cdot}85} \times d^{4{\cdot}87}}$$

Where, p = pressure loss in pipe (bar)

L = equivalent length of pipework plus bends and fittings, i.e. effective pipe length (m)

Q = flow rate through the pipe (minimum 60 litres/minute)

C = constant for pipe material (see table)

d = pipe internal diameter (mm)

Pipe material	Constant (C)
Cast iron	100
Steel	120
Stainless steel	140
Copper	140
CPVC	150

Maximum water velocity through valves is 6m/s. Through any other part of the system, 10m/s.

By determining an acceptable pressure loss as a design prerequisite, the Hazen-Williams formula can be rearranged with the pipe diameter as the subject:

$$d = \sqrt[4{\cdot}87]{\frac{6{\cdot}05 \times 10^5 \times L \times Q^{1{\cdot}85}}{C^{1{\cdot}85} \times p}}$$

See the following example.

e.g. Calculate the diameter of 30m effective length steel pipe, where the acceptable pressure loss is 0·02 bar with a water flow rate of 60litres/minute.

$$d = \sqrt[4.87]{\frac{6.05 \times 10^5 \times 30 \times 60^{1.85}}{120^{1.85} \times 0.02}}$$

$$d = \sqrt[4.87]{\frac{353554.56 \times 10^5}{140.45}} = 53.09 \text{ mm (i.d.)}$$

50mm nominal inside diameter is just too small, therefore a 65mm nominal inside diameter steel pipe would be selected.

- Fire protection and alarm systems may contain the following materials:
  - System control unit
  - Primary (mains) electrical supply
  - Secondary (battery or capacitor stand-by) power supply. An emergency generator could also be used
  - Alarm activation devices manual or automatic
  - Alarm indication devices audible and/or visual
  - Remote indication on a building monitoring system
  - Control relay via a building management system to effect fire extinguishers and ventilation smoke control actuators.
- Fire alarm zone
  - Max. 2000 m 2 floor area in one storey.
  - No detachment of compartment areas within one floor area zone.
  - Max. 30 m search distance into a zone.
  - Single occupancy of a zone where several} separate business functions occur in one building

Let see the following table and review material quantities that prepared for specific fire sprinkler system installation project

S.No.	Description	Qty	Unit	Rate	Amount
	FIRE WATER SPRINKLER SYSTEM				
1	Providing, fixing, testing and commissioning of Above Ground M.S. ERW Black C Class Heavy-duty pipes as per IS: 1239 (up to 150 mm dia.) and IS: 3589 (up to 200 mm dia. And above) including cutting, screwing, welding etc. and providing all fittings like flanges, bends, tees, elbows, reducers, clamps, hangers etc. with painting of one coat of primer and 2 or more coats of synthetic enamel paint of approved make / shade complete as per specification (MAKE TATA/ JINDAL)				
a	25mm dia	220	RMT		
b	50mm dia	100	RMT		
c	65mm dia	60	RMT		
d	80mm dia	90	RMT		
e	100mm dia	20	RMT		
2	Providing, Fixing, Testing and Commissioning of C.I. Butterfly valve conforming to I.S:13095 class PN 1.6 rating with Fittings, Flanges, Nut bolts, Washers, Gaskets etc. of size: Make Keystone/Audco				
a	80mm dia	2	No.		
3	Supply, installation, Testing & Commissioning (SITC) of pressure gauge 0-200 PSI range, 3/8" BSP bottom entry 4" dial weather proof with stainless steel internals, siphon tube and gate valve/ Isolation cock including fittings, etc. complete as required with Ball Valve.	2	No.		
4	Sprinkler Head (HD/Tyco /Viking any Standard Brand/Approved Brand) with complete fitting (below false ceiling)	150	No.		
5	Metallic Flexible pipe for sprinklers head (As per number of Sprinklers in down)	150	No.		
6	Supply and installation of flow switch 80 MM dia Make System Sensor/Potter	2	No.		
7	Sprinkler control valve / Gaung Bell.	1	No.		
8	Air release valve	2	No.		
9	Pressure switch Make H Guru/KI	2	No.		
10	Ball Valve 25 MM	2	No.		
	Total				

Hydraulic calculations

Full hydraulic calculations should be carried out for each system to determine the required pressure and flow, which in turn determines the required water supply.

All possible locations for the most unfavorable and favorable areas of operation should be assessed, to determine the maximum required system pressure and system flow.

The system flow rate should be not less than:

A. Flow determined by multiplying the discharge density (see the Table below) by the maximum area of operation; and
B. Flow at the minimum pressure specified by the manufacturer for that area of operation; and
C. Minimum flow rate as per hydraulic calculations

Table: **Hydraulic calculations**

Category of system (see Table 1)	Minimum design discharge density	Number of design sprinklers (see 5.5)	Minimum duration of supply
	mm/min		min
1	2.10[A)]	1 or 2	10
2	2.80 [B)]	1 or 2	30
3	2.80 [C)]	2 to 4 [D)]	30
4	2.80	4	60

Components of Hydraulic calculations

1. **Static pressure:** The static pressure difference between two inter-connecting vertical points in a system should be calculated from:

$$p = 0.098h$$

Where:

p is the pressure, in bar;

h is the vertical distance between the two points, in metres (m).

NOTE: If the calculations are undertaken by hand then the value of p may be rounded to 0.1.

2. **Flow from a sprinkler head:** The flow from a sprinkler head should be determined by the following formula:

$$Q = kp0.5$$

Where: Q is the flow, in litres per minute (L/min);

k is the constant, sprinkler head nominal k-factor;

p is the pressure, in bar.

3. **Pipe friction losses:** The pressure loss at a given flow through the pipe work should be calculated using the Hazen–Williams formula:

$$p = \frac{(6.05 \times 105\ ) \times L \times Q1.85}{C1.85 \times d4.87}$$

Where:

p is the pressure, in bar;

C is a constant for the type and condition of the pipe (see Table D.1);

d is the mean internal diameter of the pipe, in millimetres (mm);

L is the equivalent length of pipe and fittings, in metres (m);

Q is the flow, in litres per minute (L/min).

Table C.1 – C values for various type of pipes

Type of pipe	Value of C
Carbon steel	120
Copper	140
CPVC	150
NOTE This list is not exhaustive. Other values are given in BS EN 12845.	

The pressure loss in the pipe work for any given flow should be calculated using the appropriate K value by using the following formula:

$$p = K \times Q1.85 \times L$$

Where:

p is the pressure, in bar;

K is a constant for the pipe type given in the above Table

Q is the flow, in litres per minute (L/min);

L is the equivalent length of pipe and fittings, in metres (m);

2.3. Maintenance tasks and schedule

In order to meet both international and federal requirements, automatic fire sprinkler systems are required to be inspected, tested and maintained in accordance with NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

2.3.1. Maintenance tasks

In order to follow the requirements of the standard, it's important to have a good understanding of what is meant by "inspection", "testing" and "maintenance": Those terms are defined as follows:

Inspection is defined as, "A visual examination of a system or portion thereof to verify that it appears to be in operating condition and is free of physical damage."

Testing is defined as, "A procedure used to determine the operational status of a component or system as intended by conducting periodic physical checks, such as waterflow tests, fire pump tests, alarm tests, and trip tests of dry-pipe valves."

Maintenance is defined as, "In water-based fire protection systems, work performed to keep equipment operable or to make repairs."

The technician will inspect and maintain all components of fire sprinkler system, including:

- Gauges
- Control valves
- Alarm devices
- Hangers/bracing
- Pipes and fittings
- Sprinkler heads
- Antifreeze solution
- Pre-action/deluge valves
- Backflow prevention components
- Main drain
- Water flow alarm

They will also check for any necessary repairs or obstructions that would prevent the system from protection your building's life and property in the event of a fire emergency.

When it is necessary to clean sprinkler system, always practice caution, or call an expert who can inspect, maintenance or install fire sprinkler correctly.

May also follow these following fire sprinkler cleaning tips:

1. Gingerly vacuum around the sprinkler head with the vacuum hose attachment. Be careful not to touch the sprinkler head with your hands or the vacuum tool.
2. Dampen a small rag focus on clearing away any residual dust or cobwebs that accumulate around the fire sprinkler head.
3. Using a canned air sprayer (much like the one you may clean your keyboard with), hold the can upright and spray the entire surface of the sprinkler head.

2.3.2.Maintenance schedule

For a maintenance or inspection checklist for fire sprinkler, it is necessary to look the following, provided breakdown of maintenance steps take with fire sprinkler systems.

Weekly inspection schedule for sprinkler systems

- **Gauges** – the gauges on dry, pre-action, and deluge systems should be inspected weekly. In this step, you're looking for a normal read on air and water pressure.
- **Control valves** – you should check these weekly to ensure that they are free from leaks, locked, properly sealed, and in the open position. Proper signage should identify what part of your sprinkler they control.

Monthly inspection schedule for sprinkler systems

- **Gauges (on wet pipe systems)** – you should check that the water pressure is maintained and that there is no sign of physical damage.
- **Alarm valves –** these should be externally inspected each month.

Quarterly inspection schedule for sprinkler systems

- **Alarm devices** – every three months, check that these are free from physical damage.
- **Hydraulic nameplate** – check that this is secured to the sprinkler riser and legible.

Annual inspection schedule for sprinkler systems

The NFPA requires that you have a licensed technician inspect your fire sprinkler system annually to keep your building safe and up to code.

See Monthly inspection schedule checklist for sprinkler systems below:

MONTHLY FIRE PREVENTION INSPECTION

Location			Inspected by:					Date:	
FIRE PROTECTION CONTROL VALVES (INSIDE & OUTSIDE)									
Valve Number	Area Controlled	Open	Shut	Supervised	Locked	Valve Condition Satisfactory	Valve Readily Accessible	Any Evidence of Leakage	Operating Wrench in Place
AUTOMATIC SPRINKLER SYSTEMS									
Dry Pipe Systems	System #								
	Air Pressure								
	Water Pressure								
Wet Pipe Systems	System #								
	Water Pressure								

Physical condition of all sprinkler system gauges satisfactory ☐Yes ☐No

Physical condition of all sprinkler system alarm devices satisfactory ☐Yes ☐No

Alarm valves/dry pipe valves found to be in a good condition and free of any physical defects

☐Yes ☐No

Fig. check list of maintenance

2.4. Faulty items or components identification

Sprinkler pipes that could be collapsed because they were used to support cables and other items. Building staff shutting off activated sprinklers to avoid water damage while the small fire they failed to notice spirals out of control.

Burst pipes preventing sprinklers from working because the system wasn't winterized properly.

Automatic fire sprinklers are a proven first line of defense when fires break out, controlling 96 percent of the blazes that trigger them. But the National Fire Protection Association (NFPA) reports that fire sprinklers fail or operate ineffectively 7 percent of the time and more often than not, human error is to blame.

In this lessen, we shine a light on common mistakes that cause fire sprinkler failure, from simple-but-serious actions like shutting off the system to more complicated errors like installing systems that can't control the intensity of fires generated by a property's hazards.

2.4.1. Causes of faulty items or components

Human error causes a whopping 93 percent of fire sprinkler failures. Before quick look at fire sprinkler system performance by the numbers. When installed properly, NFPA reports that fire sprinklers operate effectively in 92 percent of fires. When they fail, the chart below breaks down the biggest reasons why:

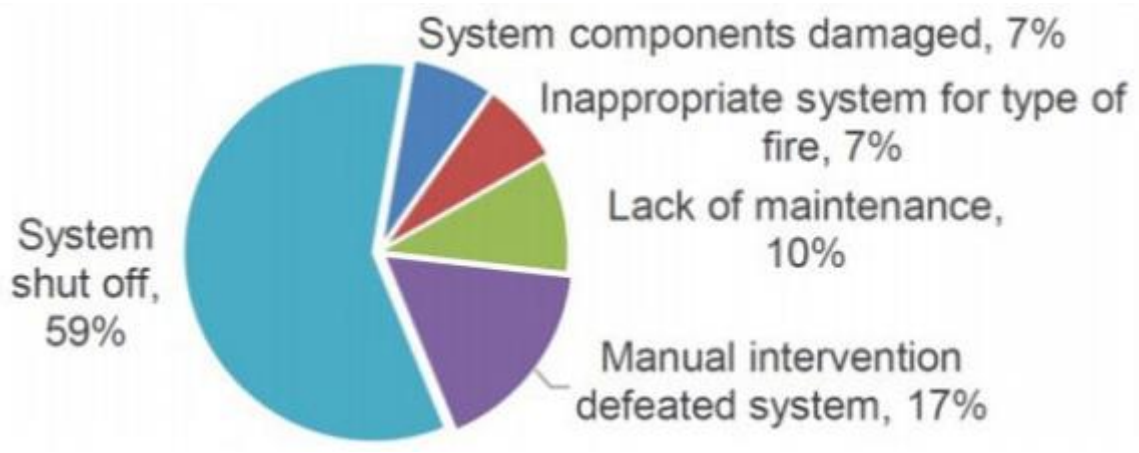


Fig. reason for sprinkler failure

That means human error is responsible for a whopping 93% of fire sprinkler failures. Only 7 percent are caused by damage to system components. And even then, people still often play a factor, with damage occurring during shipping, installation, or accidental impacts in gymnasiums, warehouses, and other risky environments.

Carelessness and oversights can lead to corrosion, obstructions, mechanical failures, and inadequate sprinkler coverage that leave people and property vulnerable. They can also spur code violations that impose hefty fines on property owners or complete building shutdowns.

Fixing mistakes can also be costly: repairing small leaks in sprinkler pipes costs an average of between $800 and $1,200, for instance, and replacing ruptured pipes averages between $6 and $8 per square foot.

Most fire sprinklers don't work for the simplest reason: The system was shut off

Almost two-thirds of fire sprinkler failures 59 percent happen because somebody simply turned the system off. Reasons vary: perhaps the building is vacant or under construction, or the system has been struggling with leaks or other emergency impairments and was shut down in preparation for a fix. Homeowners often shut off the water to their homes to avoid leaks while they're on vacation and don't necessarily consider that they're also cutting the sprinkler system's water supply.

2.4.2. Types of faulty items or components

Occurrences of fire sprinkler malfunctions are exceedingly rare. But when they do happen, it's usually the result of the following Common Sprinkler components failures

1. **Overheating** – sprinkler heads are activated by heat, going off when the temperature in a specific location gets too high. When installing a fire sprinkler, make sure you take into consideration the hottest your room can get, even during the summer heat. Different sprinkler heads are designed to go off at different temperatures, so if your ceiling temperature gets to 155 F, you'll want to install a 200 F sprinkler head, and so on.
2. **Freezing** – in the exact opposite situation, the water in fire sprinklers can freeze if proper precautions, including adding antifreeze and insulating the pipes, aren't taken into account. Freezing water can cause pipes to expand, crack, and burst, and then leak when the system thaws out. Common solutions to this problem include adding anti-freeze solutions to the pipes, adding insulation around the system, or installing dry fire sprinklers that leverage air pressure and specially designed valves to keep water out of the system until needed.
3. **Corrosion** – like any water-based system, fire sprinkler pipes are subject to corrosion that can impact the functionality of the system and potentially lead to leaks. Annual fire sprinkler system inspection should keep you protected from this.
4. **Mechanical damage** – poorly installed and maintained fire sprinkler systems are at risk of mechanical damage, which can be caused by over-tightening fittings, not properly installing

sprinkler heads, and a variety of other installation mistakes. Hiring a qualified fire sprinkler installation professional will reduce the likelihood of these errors to almost zero.

5. **Human sabotage or error** – the most common cause of fire sprinkler failure is human error. Common examples of this are hanging items from the fire sprinkler, knocking into it with a forklift, and painting over the sprinkler head, etc. Make sure people around building know not to touch fire sprinkler heads for any reason!!

Self check-2

Instruction I: select the correct answer for the give choice. You have given 1 Minute for each question.

1. Stop valve is often painted
   A. Yellow
   B. Red
   C. Black
   D. Green
2. _____ is used to control the flow of water into the fire sprinkler system
   A. Alarm valve
   B. Stop valve
   C. Alarm check valve
   D. A and C
3. Which of the following type of pipe is heavy and usually requires special equipment to
   A. Steel pipe
   B. CPVC pipe
   C. Galvanized pipe
   D. None of the above
4. It is the most common head Extends down from a ceiling Sprinkler sprays a stream downward onto a deflector.
   A. Upright
   B. Side wall
   C. Pendant
   D. Alarm bell
5. The first steps of estimation of material quantity is
   A. Squaring out
   B. Taking out
   C. Abstracting
   D. Working up

Instruction II: write short answer for the given question. You are provided 3 minute for each question.

1. Write at list three components of sprinkler with their functions
2. Write the advantages of CPVC pipes.
3. List types of pipe used in sprinkler system installation.
4. What is the function of alarm

Operation Sheet-2.1: plan and preparing work

Purpose: To apply quality work and health care

- **Instruction:** Follow the given procedures and use the appropriate and required tools, materials and equipment prepare the working area safe for fire sprinkler installation work. For this operation you have given 1Hour.
- **Equipment Tools and Materials:**
  PPE, hand tools and equipments
- **Precautions:** During performing the job you should have Safe working area environment and use available tools and equipments
- **Procedures in doing the task**

Step-1: Secure workshop manuals, Specifications, and tools and equipment;

Step-2: Prepare the workstations for installation works;

Step-3: Select appropriate methods based available materials

Step-4: Select appropriate safety tools

Step-5: Observe the proper application of Occupational Health and Safety requirements.

Step-6: Follow the instruction and done the work

- **Quality Criteria:** Assured the performance of all the activities according to the given guide

Operation Sheet-2.2: Calculate Counted Item Of Material Quantity

- **Purpose:** To calculate quantity of material.
- **Instruction:** Follow the given procedures calculate the material needed to install and do the job for the given Drawing. For this operation you have given 1.5Hour.
- **Equipment Tools and Materials:**

  Paper

  Pen or pencil

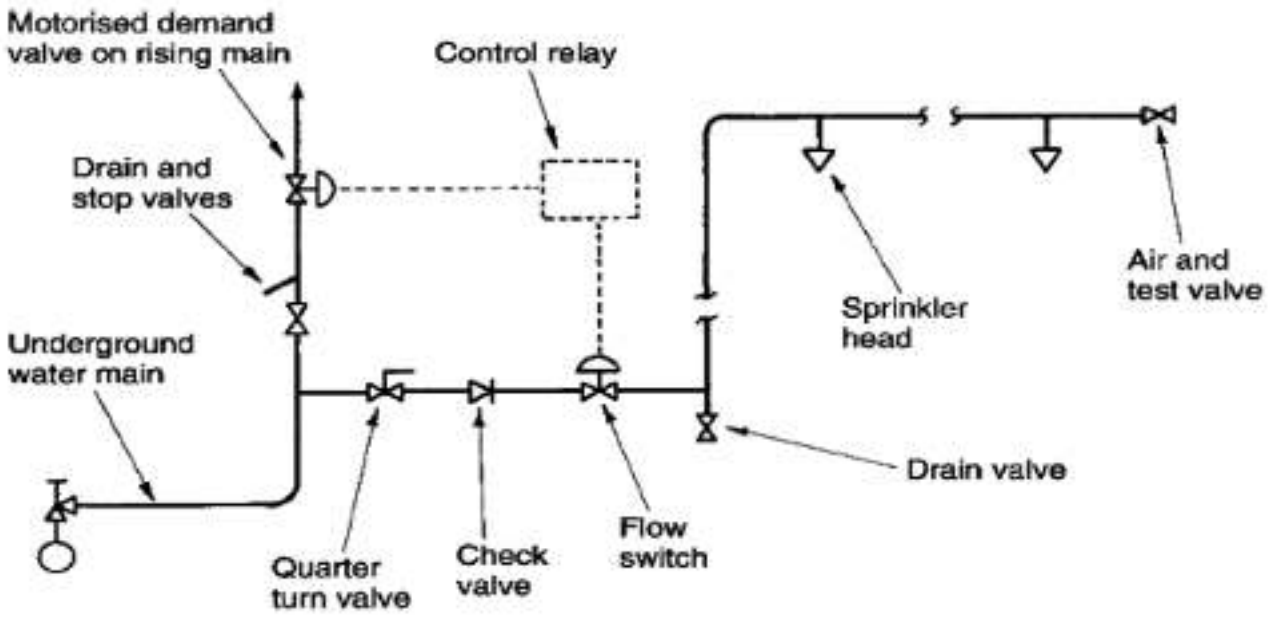
  Ruler
- **Procedures in doing the task**

  Step1. Taking out

  Step2. Squaring out

  Step3. Abstracting

Quality Criteria: Assured performing of all the activities according to the procedures



Lap Test-2.1

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks accordingly.

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates /guide, workshop, tools and materials you are required to perform the following tasks within 1:30 hours.

Task 1. By using the given guide, Identify safe work area requirements

Task2. By using the given guide identify the proper tools and equipments for the work

Task3. By using the given guide calculate the required materials.

Unit Three: Installation of system components

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

- Setting- out system.
- Install, pipe supports.
- Device alarms and piping materials
- Jointing systems.
- Pressure Testing and recording test data
- Replaceable items and replacement services

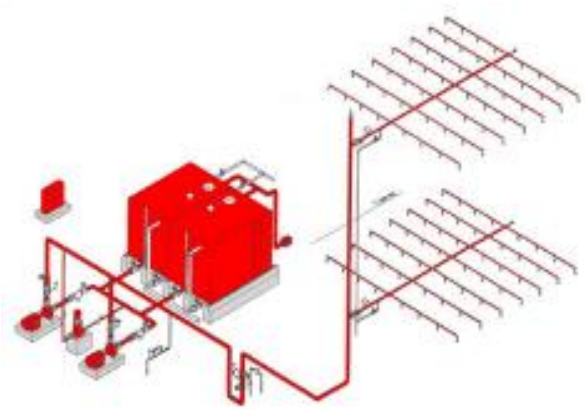
This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Perform Setting- out system.
- Install pipe supports.
- Install jointing systems.
- Apply testing system.
- Recording test data

3.1. Setting- out system.

Setting out Piping is network a system of pipes and trenches which provide the appropriate quality and quantity of water flow to a fire protection sprinkler system. The design, construction and layout of the piping network have to be carefully prepared in order to ensure that there is enough flow pressure to supply safe water sprinkler system.

Once the network is constructed, its maintenance has to be performed, which includes repairs, leakage control, prevention of recontamination, etc. Along with maintenance, the proper operation of pumping stations has to be ensured for areas where gravity pressure alone is not enough see the figure below.



- **Requirements of setting out for an Adequate Distribution System:**

For an adequate water distribution for fire protection sprinkler system, the requirements are as follows:

A. Water quality should not deteriorate while flowing through the distribution pipes.
B. The system should be capable of supplying water to all the intended places with sufficient pressure head.
C. It should be capable of supplying the required amount of water during firefighting.
D. The layout should be such that no consumer is without water supply, during the repair of any section of the system.
E. It should be fairly watertight to minimize losses due to leakage.

The design of water distribution for firefighting consists of the following main steps:

1. **Preliminary Studies**: - This is the first and the most important step in the designing of fire sprinkler system system. Before any design work can commence, thorough observations and studies have to be carried out.

Preliminary studies consist of the following sub-steps:

A. Topographical studies must be performed before starting the actual design work.
B. Digital maps showing present (and future) houses, streets, lots, and so on should be made.
C. Location of water sources and pumping stations should be considered so that distribution reservoirs can be easily located.

2. **Design Phases**: – After the preliminary studies are performed, the next step is setting the Design Criteria. This step involves setting the required design limitations/parameters that are required to get the most effective and economical water-distribution in the chosen network.

The required limitations/parameters can determined on the basis of the following factors:

. **Hazards classification**: System depends not only on the size of the risk but also on its fire growth and spread potentialities, the risk are to be categorized under following classes (Figure 3) for the purpose of system design.

- Light hazard
- Ordinary hazard–1
- Ordinary hazard–2
- Extra-ordinary hazard–1
- Extra-ordinary hazard–2

Pipe size: Water pipe sizing procedures are based on a system of pressure requirements and losses the sum of which must not exceed the minimum pressure available at the supply source. The required pipe size is chosen to maintain the flow/cost effectiveness

Network setting out: - After the design criteria are determined, the next step is to choose a suitable pipe network layout and to estimate pipe sizes on the basis of water demand and local code requirements.

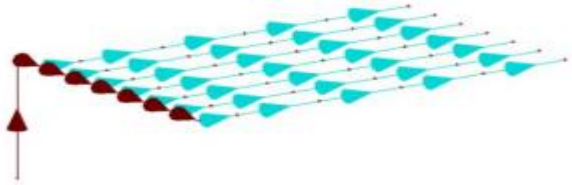
The pipes are then drawn on a digital map (using AutoCAD, for example), starting from the water source (Figure 7). All the components i.e. pipes, valves, fire hydrants, etc. of the water network should be shown on the lines. These layouts are used by project executers (contractors) for implementation (installation).

Figure-7: A screen-shot of piping in AutoCAD layout

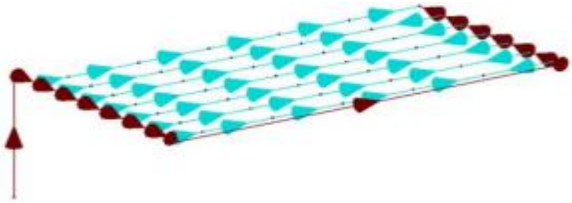
There are 3 types of piping setting out possible in fire protection designing.

They are:

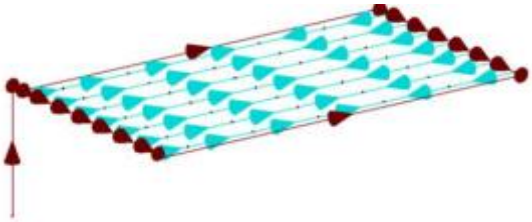
A. Branching pattern with dead end. (Tree system)



B. Grid pattern (Gridiron system)



C. Grid pattern with loop. (Circular or ring system)



4. **Hydraulic Analysis (Of Distribution Systems)**:- After the suitable type of pipe layout is chosen, the next and final step involves the analysis of the chosen layout. This involves calculating the flow rate, supplied water pressure, volume, losses, etc. The calculation process is done using hydraulic analysis software like Sprinkle CALC, Pipe NET, and Sprinkle CODE etc. These soft wares are designed especially for calculations of piping for fire protection systems.

The following example layouts of residential fire sprinkler system

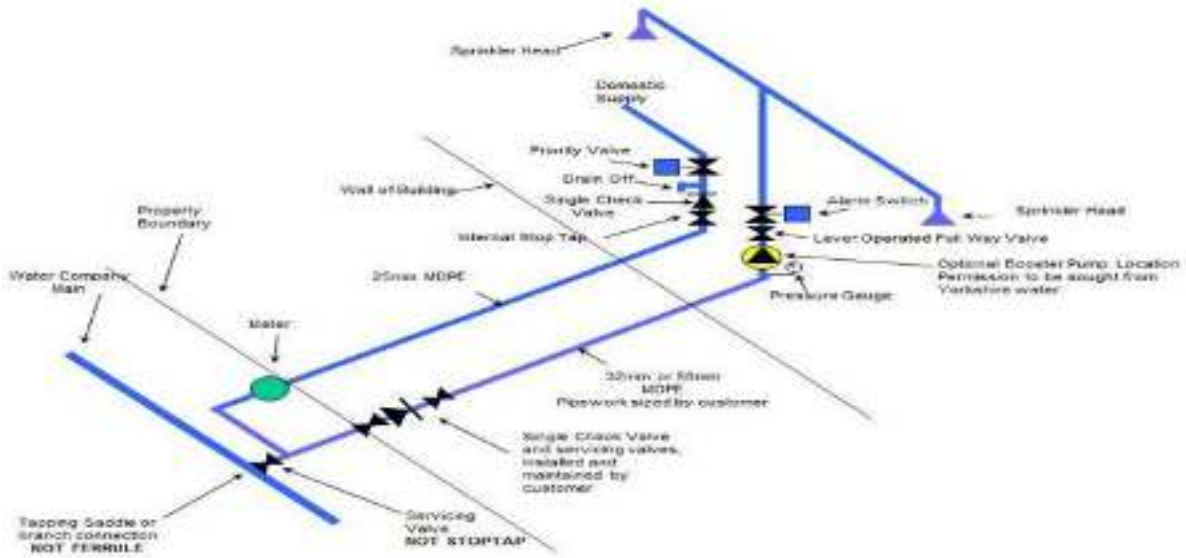


Figure - New House with Separate Fire Main and External Meter

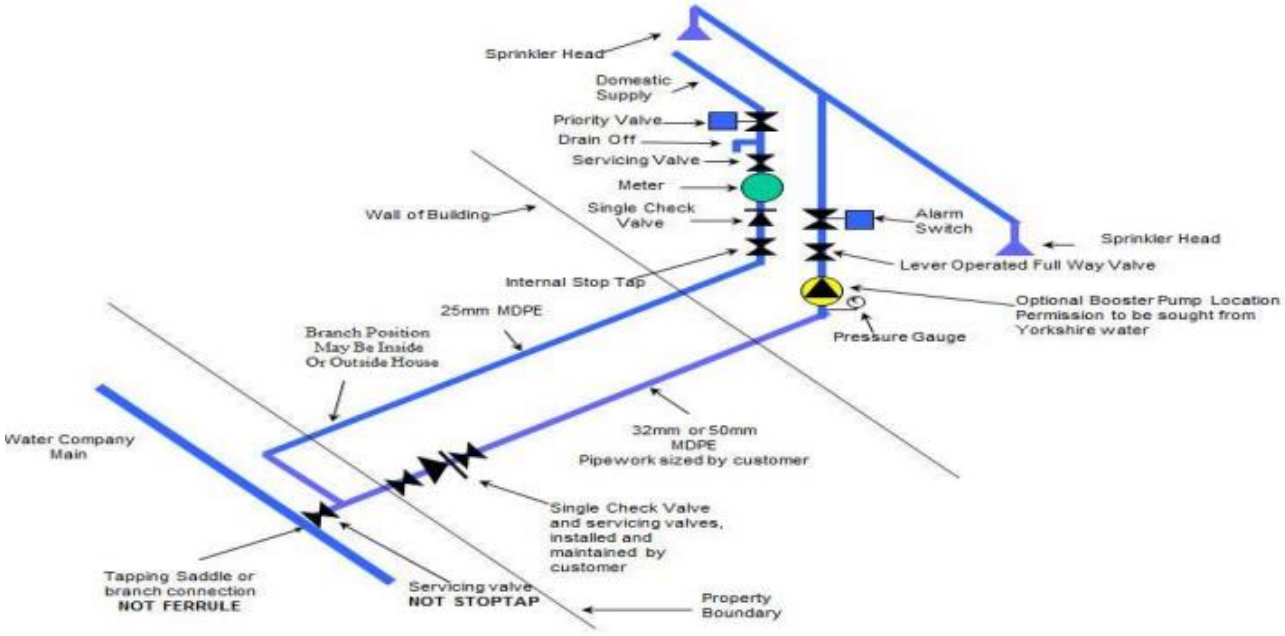


Figure - New House with Separate Fire Main and Internal Meter

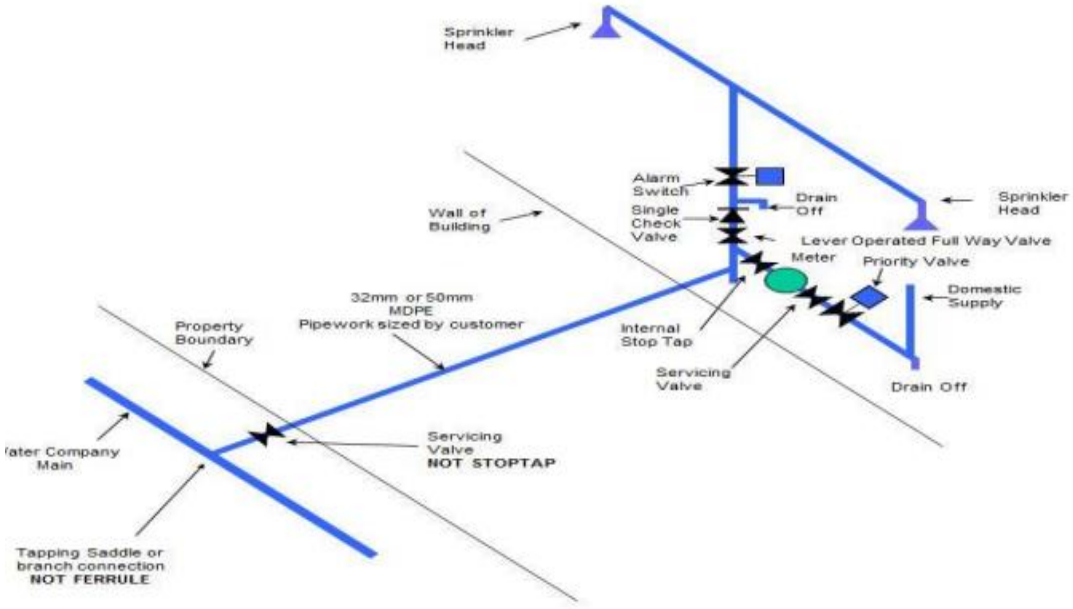


Figure - New Residential Premises with Internal Meter

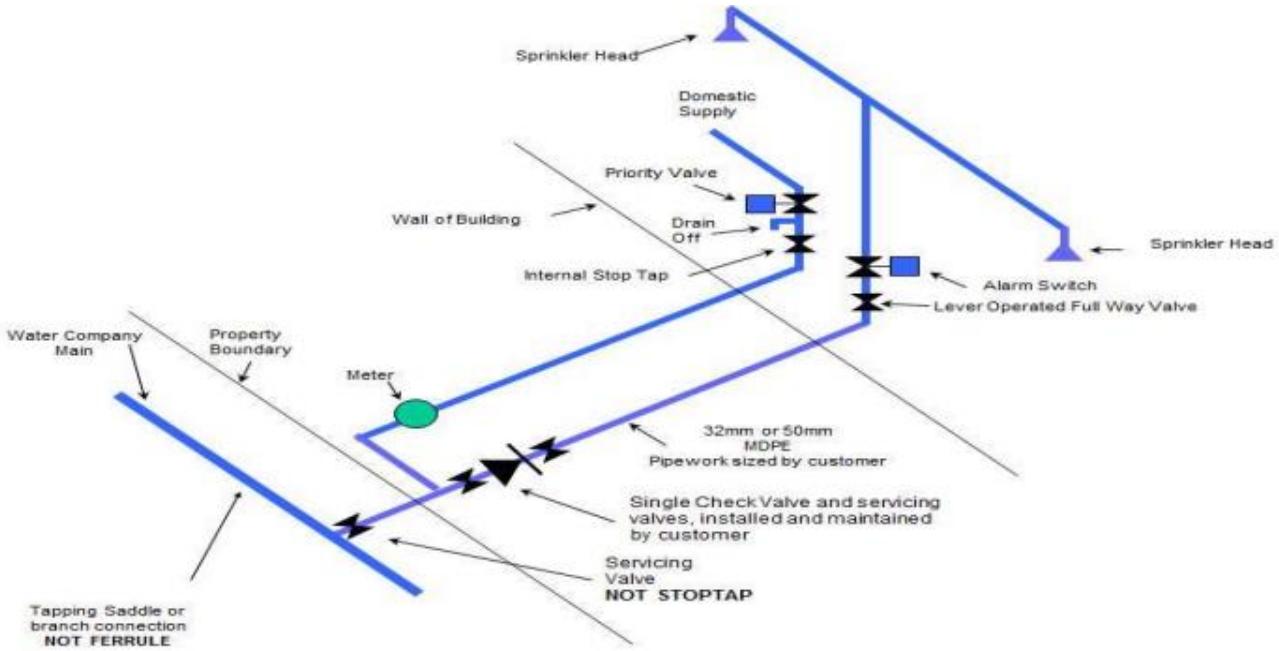


Figure - New Residential Premises with Externally Sited Meter

3.2. Pipe supports.

In addition to the main components of the fire sprinkler system, there are a series of ancillary (support) components that regularly form part of an automatic fire sprinkler system.

1. **Pressure Switch**: is an electro-mechanical device that monitors a fire sprinkler system for a rise or fall in water pressure after the alarm valve. The purpose of monitoring water pressure is to activate a switch that is monitored by a fire alarm panel or alarm signalling equipment, as the primary method for signalling an alarm to the fire brigade.
2. **Flow Switch**: is an electro-mechanical device that monitors the flow of water through a section of pipe within an automatic fire sprinkler system. Flow switches are often fitted with a mechanical delay (up to six minutes) preventing small or minor water flow fluctuations from signalling an alarm. When sustained water flow is detected by a flow switch, a signal is transmitted to a fire indicator panel. This signal is then used to determine which section (floor) of a fire sprinkler system has water flow. Note: Most flow switches fitted to automatic fire sprinkler systems are NOT set to automatically call the fire brigade.
3. **Jacking Pump**: Jacking is manual (hand) or electric (semi-automatic or fully automatic) pumps are not always fitted to an automatic fire sprinkler system. They however provide a method of pumping (boosting) water from the water supply to the fire sprinkler system after the alarm valve. This leads to an increase in water pressure in the fire sprinkler system, thus forcing the alarm valve into the closed position. Jacking Pumps have a secondary function of maintaining the water pressure within a fire sprinkler system reducing the likelihood of false alarms caused by low pressure, caused by small water leaks.
4. **Pressure Gauge**: A pressure gauge us a mechanical device that is usually fitted to an automatic fire sprinkler system. There are usually two gauges fitted to a system, one showing the water supply pressure and the second showing the installation pressure. Normally the pressure differential should be not less than 200 KPa.

3.3. Install Device, alarms and piping materials

It is necessary to conduct a site assessment to determine what type of fire sprinkler system devices are most suitable for the hazards present in your environment. Installation technicians should fully trained, fluent in NFPA standards, and provide fire sprinkler installation services for all types of systems, including:

- Deluge
- Dry pipe
- Wet pipe

Fig. Devices, alarms and piping materials

Automatic fire alarm system: Automatic fire alarm systems perform a series of operation; detection of heat, smoke or flame of a fire with detector, sending a fire signal to a control panel to make an alarm go off for notification of fire, and prompting evacuation and first response firefighting.

This is a basic alarm system that provides early warning of a fire to occupants in the building, so that evacuation, fire extinguishing, etc., can be carried out effectively.

- **Feature of automatic fire alarm system**
  - According to the transmission method of fire signal, there are P-type (Proprietary-type ; It also referred as conventional type) systems(equipment centering on P-type control panel) and R-type (Record-type ; It also referred as analog-addressable-type) systems(equipment centering on R-type control panel).
  - P-type control panel are installed in small and medium-sized buildings, and R-type control panel are installed in large buildings (over 10,000 m2).

Home fire alarms: A home fire alarm consists of a sensing part and an alarming part, etc. to detect a fire and make an alarm go off at an early stage of fire.

- **Features of home fire alarms**
  - The battery life is about 10 years, and the alarm is sounded in case of failure or shortage of battery.
  - Maintenance is easy because it can be easily checked by alarm sounds with the button.
  - It can easily be installed on the ceiling or upper part of the room, which can easily detect smoke.

- A device has prevention function of false alarms caused by phenomena, such as cooking smoke, cigarette smoke, insect and dust.

When a fire is detected by a home, fire alarm installed in the house, all the home fire alarm systems in the house work together to emit an alarm sound.

- **Characteristics of the communication system for fire alarm:**
  - No distinction is made between main and secondary units
  - Group registration is possible from any fire alarm
  - With retransmission function, first alarm that is missed is retransmitted by another fire alarm.

Photoelectric smoke alarm: A device that have prevention function of false alarms caused by phenomena, such as cooking smoke, cigarette smoke, insect and dust

Constant temperature type heat alarm: A device that uses a heat sensor for downsizing a device.

Fig. fire alarms

The procedures for fire protection sprinkler system installation are mentioned as follows:

1. Run the pipes:, placing them at least six inches deep, but preferably eight to 10 inches,
2. Assemble the zone valves above ground and cement them to the underground piping,
3. Install an inline drain fitting on each valve's downstream side before connecting cable wires,
4. Install brass drain valves at every low point along the feed line,
5. Connecting and wiring all the valves before installing valve boxes and backfilling the excavated area,
6. Install sprinkler heads, tap into your home's water line and
7. Install the backflow preventer and the sprinkler system's control panel to finish things off.

3.4. Installation of jointing systems.

A mechanical joint in a pipe is a type of connection used to connect pipes, valves, and other components of a firefighting system. It typically consists of a bell with a flange cast integrally with it, a cast or ductile iron gland, and a rubber gasket.

Jointing in the four types of sprinkler systems are discussed below:

3.4.1. Jointing systems for Dry pipe Sprinkler System

Dry pipe sprinkler installations are appropriate for applications either where there is a danger of the water in the pipes freezing or in situations where there may be temperatures above about 70ºC. In a dry-pipe system the pipes on the active side of the installation control valves are charged with air which is under sufficient pressure to prevent the entry of water into the delivery pipe work.

A dry pipe system is connected to a water source but is filled with compressed air. The system still offers automatic protection, but the valve must first be triggered before water floods the pipes.

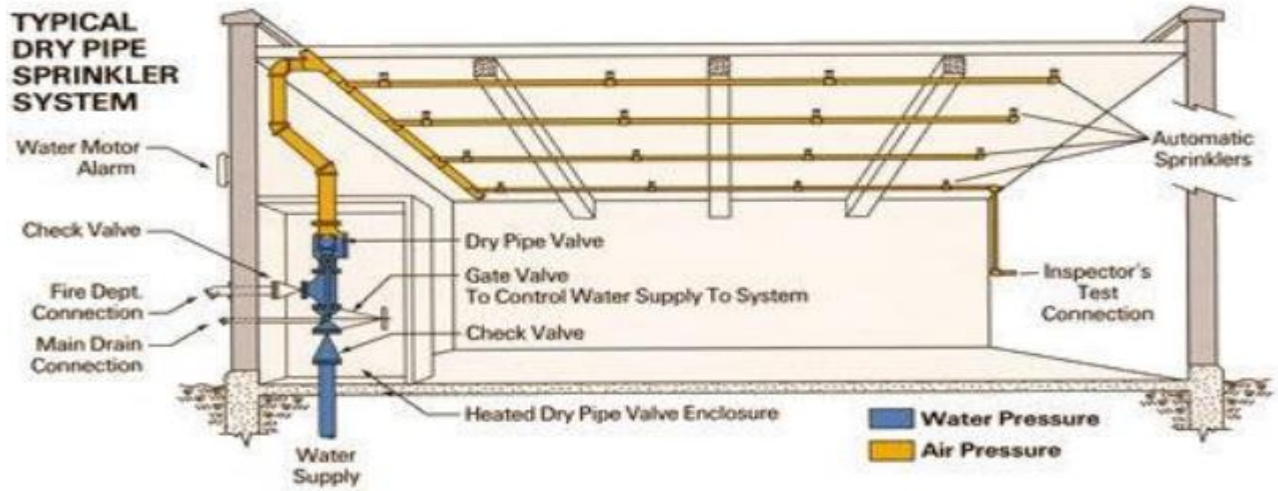


Fig. installation of dry pipe sprinkler jointing

3.4.2. Jointing systems for Wet pipe Sprinkler System

Types of Systems a wet-pipe system is where all the pipes leading from the water supply, through the various control valves and on to the sprinkler heads, are permanently filled with water under pressure.

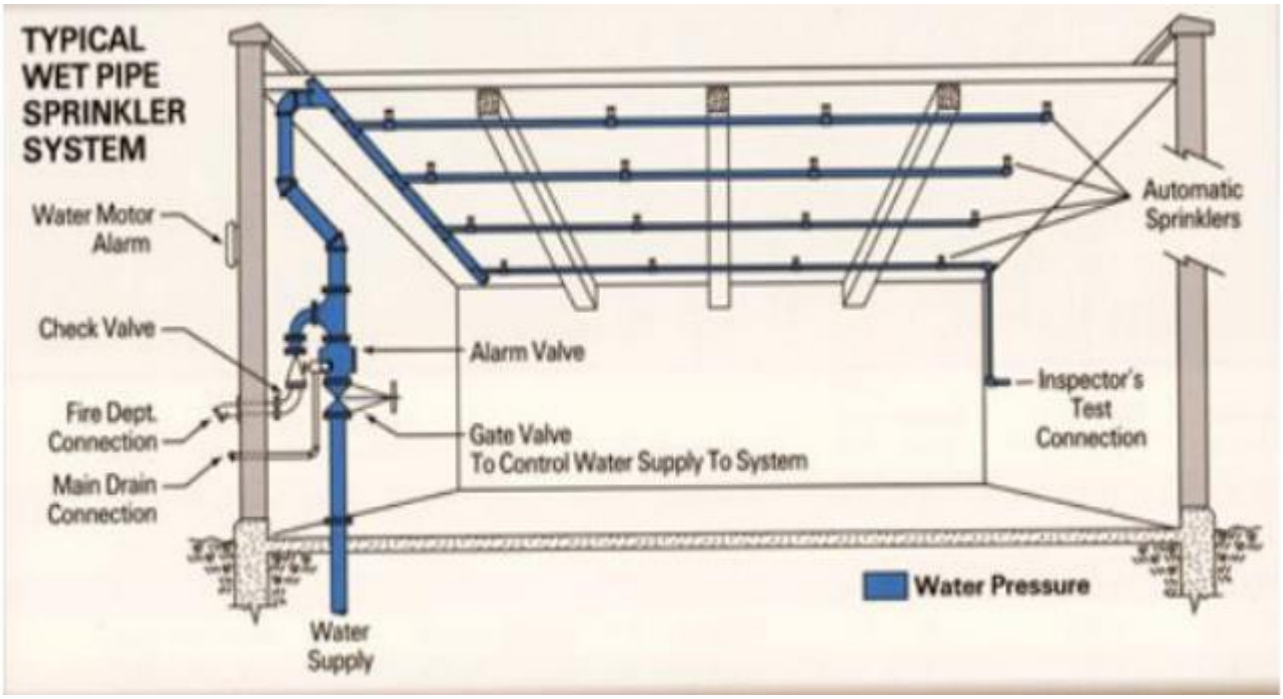


Fig. installation of wet pipe sprinkler system jointing

3.4.3. Jointing systems for Deluge Sprinkler System

A deluge fire sprinkler system is similar to a pre-action system except the sprinkler heads are open and the pipe is not pressurized with air. Deluge systems are connected to a water supply through a deluge valve that is opened by the operation of a smoke or heat detection system. These types of fire sprinkler systems also need a smoke or heat detector like the pre-action system.

Deluge System These systems are commonly fitted with open nozzles or projectors and are triggered from air/water detection lines or some kind of detection system. Deluge Valves are used in special areas. Deluge Sprinkler heads are open at all times and used in high hazard areas and the Valve opens during a smoke or heat detection.

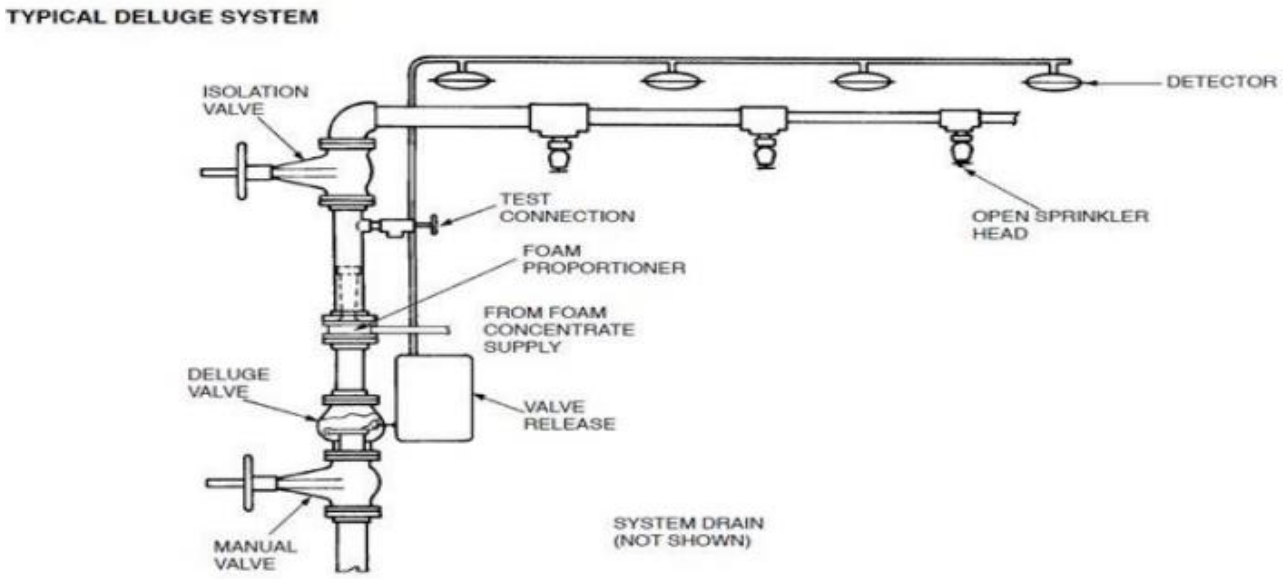


Fig. installation of deluge sprinkler system jointing

3.4.4. Jointing systems for Pre-Action Sprinkler System

Pre-action fire sprinkler systems are filled with air and water is allowed to pass through when the smoke alarm or detector goes off. This type of sprinkler system is a dry-pipe system linked to an automatic fire detection system which protects the same area.

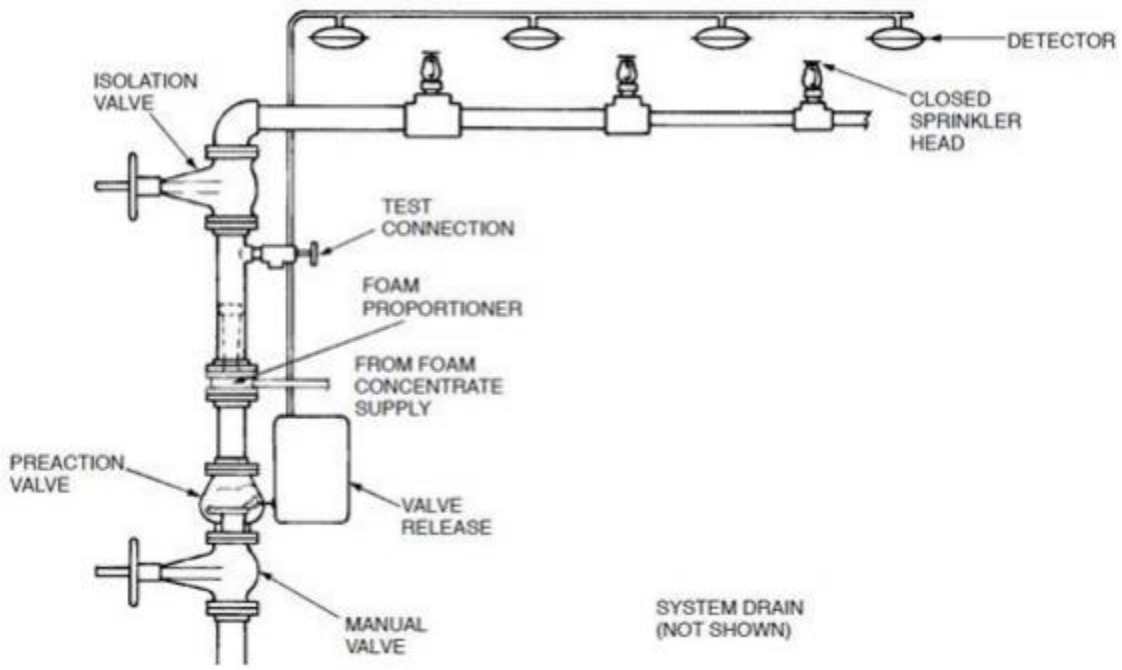


Fig. installation of pre action sprinkler system jointings

The gasket is compressed using a mechanical device, creating a positive seal that ensures the flow of water or other extinguishing agent through the system.

Mechanical joints in fire protection systems are engineered to endure high temperatures and uphold their structural soundness in the event of a fire.

These joints ordinarily include fittings, nuts, bolts, and gaskets that secure the connections within the system. When exposed to heat, the gaskets and sealing materials within the joints expand to produce a tight seal, effectively containing the spread of fire and smoke. This sealing mechanism is critical in preserving the integrity of the fire protection system, guaranteeing that water or other fire-suppressing agents can flow smoothly to extinguish the fire and shield the surrounding areas.

Fire sprinkler systems should be joint based on codes and standards with a simple but effective mechanism. Here's a step-by-step guide on how they work:

1. **Detection:** The first and most critical step in operating a fire sprinkler system is detection. The primary misconception about these systems is that they are triggered by smoke, but that's not the case. Fire sprinkler systems are designed to respond to a rapid increase in temperature, indicative of a fire. This heat detection is usually accomplished through a glass bulb within each sprinkler head.

This bulb is filled with a glycerin-based liquid carefully calibrated to respond to specific temperatures, typically between 135-165 degrees Fahrenheit.

The selection of this temperature range is strategic. It's high enough that the system won't be activated by everyday heat sources (like cooking or a slightly warmer room), but low enough to respond quickly to a real fire.

2. **Activation:** When the ambient temperature around the sprinkler head rises rapidly due to a fire, the glycerin-based liquid inside the glass bulb expands. This expansion continues until the pressure shatters the glass bulb, triggering the sprinkler head. It's worth noting that some systems might use a heat-sensitive metal alloy, known as a fusible link, instead of a glass bulb. This metal alloy is designed to melt when subjected to high temperatures, also leading to the activation of the sprinkler head.

3. Release of Water: The next step involves the release of water. Each sprinkler head in the system is essentially a valve kept closed by the glass bulb or fusible link. When the heat from a fire causes the bulb to shatter or the alloy to melt, the valve is opened. This opening allows the water held under pressure in the piping system to flow freely from the sprinkler head.

4. Water Discharge: How the water is discharged from the sprinkler head is specifically engineered to fight fires effectively. Instead of simply pouring down, the water is sprayed out in a specific

pattern designed to cover as much area as possible and thoroughly soak the immediate vicinity. The force of the water's discharge is propelled by the pressurization within the system, which ensures the water can reach far enough to suppress the fire and prevent it from spreading.

3.5. Pressure Testing and recording test data

Fire sprinkler system testing are also vital pieces of the overall process. A test is a more involved physical check to make sure the fire sprinkler system not only looks like it's functioning, but actually works as it should. Routine sprinkler maintenance and repair are critical to keep fire sprinklers in good working condition.

Quarterly inspections, semi-annual, and annual fire sprinkler system testing and tagging must be performed and documented by a licensed technician in accordance with NFPA25 and. Inspection tags for fire sprinkler systems must be current

Fire sprinkler system maintenance and testing is a vital step in the process that should never be skipped. In fact, without proper fire sprinkler maintenance, your fire sprinkler system may appear in working order and test okay once a year, but without lubrication, tightening of loose bolts, cleaning, and clearing lines, fire sprinklers may experience a shortened life span and may not work during a fire.

Be sure to follow the below sprinkler test schedule to ensure your systems are working.

- As needed: repair and maintain parts that appear questionable during visual inspections/testing.
- Annually: lubricate control valves, clean interior of the pre-action/deluge valve and dry pipe valves; repair/replace parts as needed.
- Other: Examine systems for internal obstructions where conditions exist that could cause obstructed piping.
- Test and Correct if it has not been corrected or the condition is one that could result in future obstruction of piping despite previous flushing procedures.

During testing fire sprinkler technicians should complete:

- Inspection to determine if the system is in service and in satisfactory condition
- Identification of conditions that could compromise the performance of the mechanical and electrical components of the system
- Inspection for adequate clearance, condition, and position of the sprinkler heads to allow for proper distribution and activation

- Inspection of the sprinkler control valves for proper position, condition, accessibility, and appropriate signage

3.5.1. Recording test data

Conducting test and inspections, records conform to the design specifications of the type and model to be notified by using test equipment and methods.

The recorded test data document should included the followings information:

1. Model and type of machinery and equipment subject to test
2. Design documents used for testing
3. Testing items, contents and judgment method
4. Date and place of the test
5. Equipment and measuring instruments used in the test
6. Name of the person who conducted the test
7. Quantity of Machinery and Equipment subject to Self-labeling that have been inspected
8. Inspection results
9. If the design document, test equipment or test method has been changed, the history of such change

3.6. Replaceable items and replacement services

In fire sprinkler systems, each leak repair contributes to additional corrosion activity in the system. After enough corrosion damage has occurred in the pipe network, new oxygen introduced from a single leak repair can be enough to cause the next leak. Theoretically, this would cause a never-ending cycle of leak and subsequent leak repair. When we review the history of fire sprinkler systems we work on, we very commonly find an increase in leak frequency over time.

So in order to overcome such problems may be it is necessary to replace damaged items with new

3.6.1. Replacing Supply Pipes

When replacing old water supply, use 3/4″ pipe for the main distribution pipes and 1/2" pipes for the branch lines running to individual fixtures. For convenience, run hot and cold water pipes parallel to one another, between 3" and 6" apart.

Use the straightest, most direct routes possible when planning the layout, because too many bends in the pipe runs can cause significant friction and reduce water pressure.

Remove old supply pipes that are exposed, but pipes hidden in walls can be left in place unless they interfere with the installation of the new supply pipes.

Support supply pipes every 6 ft along vertical runs and 10 ft. along horizontal runs.

3.6.2. Replacement service

In order to perform replacement services for replaced items the following procedures should be followed**:**

1. Shut off the water on the street side of the water meter, then disconnect and remove the old water pipes from the house side. Attach 3/4″ male threaded adapter and full-bore control valve to a short length of 3/4" pipe, and then attach this assembly to the house side of the water meter. Extend the 3/4″ coldwater distribution pipe toward the nearest fixture, which is usually the water heater.
2. At the water heater, install a 3/4″ T-fitting in the coldwater distribution pipe. Use two lengths of 3/4" pipe and a full-bore control valve to run a branch pipe to the water heater. From the outlet opening on the water heater, extend a 3/4" hot-water distribution pipe, also with a full-bore control valve (page 245). Continue the hot and cold supply lines on parallel routes toward the next group of fixtures in your house
3. Establish routes for branch supply lines by drilling holes into stud cavities. Install T-fittings then begin the branch lines by installing brass control valves. Branch lines should be made with 3/4″ pipe if they are supplying more than one fixture; 1/2" if they are supplying only one fixture

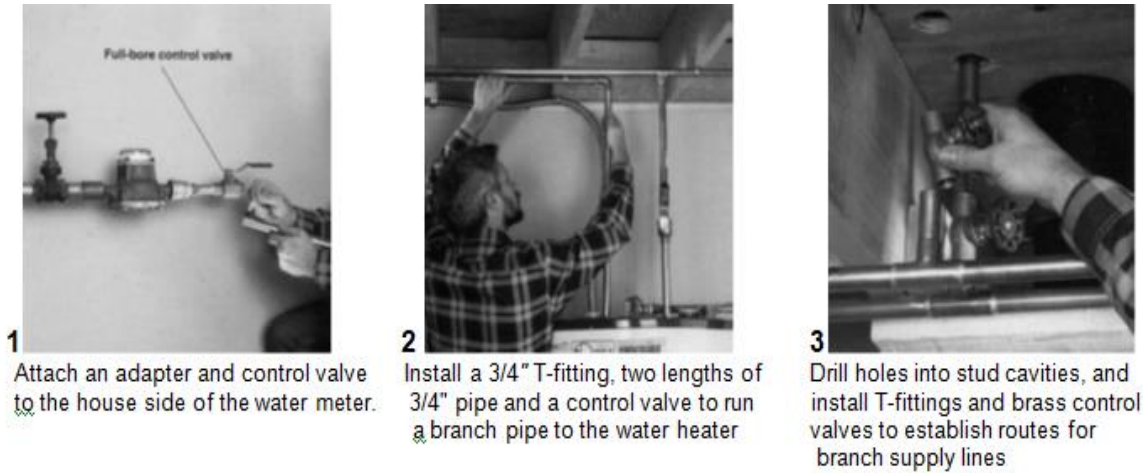


Fig. Replacing Pipes

4. Extend the branch lines to the fixtures. In our project, we are running 3/4" vertical branch lines up through the framed chase to the bathroom. Route pipes around obstacles, such as a main waste-vent stack, by using 45° and 90° elbows and short lengths of pipe.

5. Where branch lines run through studs or floor joists, drill holes or cut notches in the framing members, then insert the pipes. For long runs of pipe, you may need to join two or more shorter lengths of pipe, using couplings as you create the runs. Where branch lines run through studs or floor joists, drill holes or cut notches in the framing members, then insert the pipes.
6. Install 3/4" to 1/2" reducing T-fittings and elbows to extend the branch lines to individual fixtures.

Self check-3

Instruction I: Write True or False for the give question. You have given 1 Minute for each question.

1. Preliminary Studies is the second and the most important step in the designing of fire sprinkler system.
2. Network setting out is coming after the design phase.
3. Jacking pump is electric (semi-automatic or fully automatic) pumps but not manual (hand)
4. A pressure gauge is a mechanical device that is usually fitted to an automatic fire sprinkler system
5. Home fire alarm is sounded in case of failure or shortage of battery.

Instruction II: match column A with column B

Column A	**Column B**
1. Tree system	A. Branching pattern with dead end.
2. Circular or ring system	B. Grid pattern
3. Gridiron system	C. Grid pattern with loop.

Instruction: write short answer for the given question. You are provided 3 minute for each question

1. Write the three pipe testing methods?
2. List out considerations in planning a sprinkler system set out.
3. What is the purpose of testing a non-pressure pipeline?
4. List at least four information that included in recorded test data.

Operation Sheet-3.1: Install And Test The System

- **Purpose:** To Install and test the system.
- **Instruction:** Follow the given procedures install and test the given drawing below Horizontal lines & Main lines of water supply are ¾" & vertical lines are1/2". For this operation you have given 6 Hour.
- **Equipment Tools and Materials:**

PPE	Alarm
Cutting tools	Sprinkler heads
Pipes	Valves

- **Procedures in doing the task**

  Step1.Reading Plan and specifications

  Step2. Clearing site

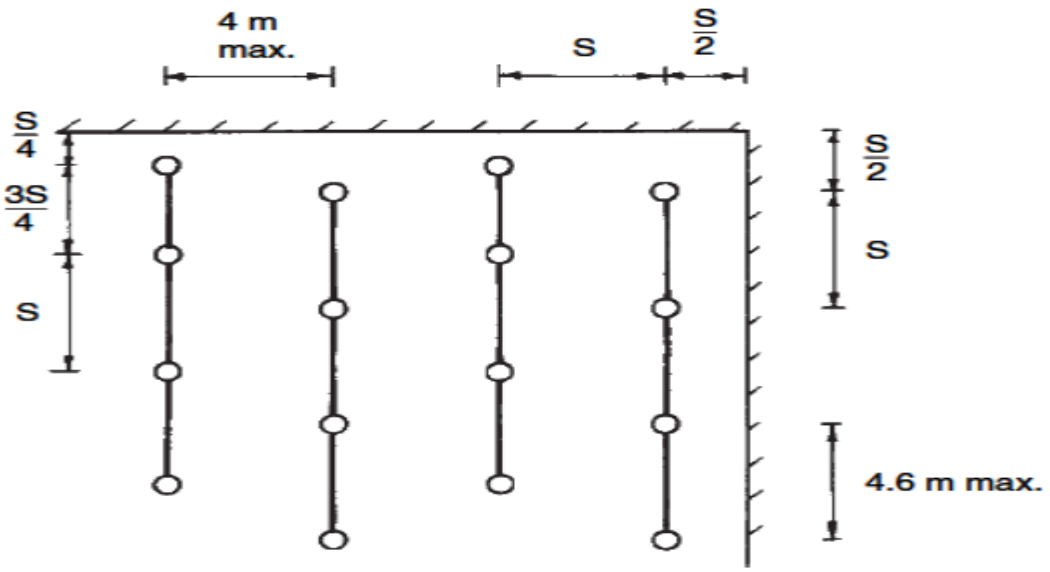
  Step3 .Applying OH&S

  Step4. Locating plant, tools and equipment

  Step5. Identify fitting

  Step6. Install and test pipe functionality

- **Quality Criteria:** Assured the performance of all the activities according to the given guide drawing.



Lap Test-3.1

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 6 hour.

Task1. Setting out pipe system and determine the length of the galvanized steel pipe required to connect the installation pipe.

Task2. Confirm accuracy of the readings taken, including set up and install of pipes in specified locations.

Task3. Accurately cut & assembles of each pipe based on the required length, to organizational requirements.

Task4. Positioning pipes based on that indicate on the drawings.

Task5. Fix alarms and devices based on the drawing and specification

Task4. Finally conduct test sprinkler system.

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1. American Society of Plumbing Engineers (ASPE) Research Foundation. 1978. Reduced-size venting design, by E. Brownstein. Westlake Village, CA.
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3. Mamas, Vincent T. 1957. National plumbing code handbook. New York: McGraw-Hill.
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