FIXED FIRE PROTECTION SYSTEMS

Topics

- Introduction
- Water-Based Fixed Fire Protection Systems
- Automatic Sprinklers
- Foam Systems
- Water Spray Systems
- Water Mist Systems
- Carbon Dioxide Flooding Systems
- Clean Agents
- Draining out Fire Water

WATER-BASED FIRE PROTECTION SYSTEMS

Introduction

- Water is used for extinguishment of class A type of fire.
- Class A type of fire includes all solid common combustible materials we use in our daily activities such as wood, paper, clothing, etc
- Water is cheaper and available than any other fire extinguisher media and has a higher heat-absorbing capacity.
- Therefore it is extensively used around the world.
- Foam based fire protection systems are also heavily relied on water supply as 94% to 97% of foam is water.

Why water is popular for fire fighting

- It's cheap
- It's available
- It's non-toxic
- It's efficient
- It's proven
- Rapid fire suppression

How does water extinguish a fire……

By cooling

- Water has high specific heat (4.2 kJ) and latent heat of vaporization (2,260 kJ) hence it can absorb a huge amount of heat energy (around 3 MJ/kg) during changing its phase from liquid to heated steam.
- The impingement of water on the solid fuel surface reduces the rate of pyrolysis by the cooling of the surface thus reduces the heat release rate.
- As fewer material burns, the flame size is reduced and the thermal feedback to the fuel is reduced.
- This further reduces the production of heat and the cycle continues until fire extinguishes.

By displacing oxygen

- Water vaporizes when it comes in contact with fire.
- The volume of water vapor is 1,700 times greater than liquid water at 100°C (212 °F) and at 600 °C (1,112 °F) it expands over 3,980 times.
- This vapor displaces the oxygen in the fire compartment area, its flammability range shrinks.
- At a certain point, the mixture will no longer be flammable and therefore rendered inert and the fire dies out.

WATER SUPPLY SYSTEM COMPONENTS

- Water source,
- Water storage,
- Water distribution systems (pipes and valves), and
- Hydrants or other end-user devices (sprinkler systems, etc.).

Water Sources

- The source of a utility's water varies around the country, and perhaps even within smaller geographic areas.
- The two sources for water supply systems are ground water and surface water.
- Although most water systems have only one source, there are instances of both.

Ground Water Sources

- Ground-water-source users receive the water from wells, where the water is pumped up from the ground; ground-level springs; or subterranean springs from which the water is either drained off or pumped out of the springs.
- Once brought to the surface it is either stored or sent through the distribution system.
- Ground-water-source users may or may not treat the water prior to distribution.

Surface Water Sources

- Surface water sources include lakes, rivers, ponds, coastal waters, and natural or artificial reservoirs.
- Surface water users usually will treat the water, since water from this source tends to be exposed to contaminants more than ground water.
- In some coastal areas the local water utility may operate a desalination plant to convert salt water to fresh water.

Two Systems

- There is a trend today, in parts of the country, to have two separate systems in the community.
- One system provides potable water and the other system supplies nonpotable water.
- Potable water is used for human consumption and for food preparation or processing.
- The nonpotable water generally is used for industrial processes, irrigation of crops or landscapes, and fire suppression systems.
- This nonpotable water is referred to as "gray water."
- It is processed water residue from sewage treatment plants; all solids have been removed, but the water is not purified enough to be potable.
- These systems use water normally discharged into lakes or rivers, or pumped underground into wells.
- By using this "gray water" the community is able to conserve the potable supply and get good use out of water that it otherwise would discard.

Water Storage

- Storage of water prior to delivery in water systems normally occurs in elevated tanks; ground-level tanks or underground storage; or a combination of elevated and ground-level tanks.

Elevated Storage

- Elevated storage tanks or reservoirs are common because they do not require pumping water into the distribution system; gravity supplies pressure to the distribution system.
- Generally a pumping system increases water main pressure in the event of a larger demand for water.
- The use of the system for firefighting could put a larger-than-normal demand on the system, and the utility company could supply larger pressures and volumes with pumps.
- In some systems elevated tanks are used solely for storage of water for fire protection.
- For these tanks to be reliable, they must be properly located, have an adequate capacity, and be of sufficient height to develop the required pressures.

Ground-Level and Underground Storage

- Ground-level storage tanks, which lack the gravitational pressure of elevated tanks, usually cannot supply the minimum pressure demands for normal use.
- Therefore, pumps maintain a minimum pressure and can increase the pressure should there be a demand.

Combination Storage Systems

- Some systems use a combination of elevated and ground-level tanks for storage.

Pumps

- The main components of water distribution systems are pumps, pipes (mains), valves, hydrants, and fire protection connections.
- Pumps provide proper pressure and volume in the water distribution system.
- Normal system pressure may have to be increased in the event an increased demand is placed on the system or part of the system.
- Such a demand may result from a main break, flushing of the system, or a large fire or multiple fires occurring at the same time.

Pipes (Mains)

- Water mains form the foundation of a good water supply.
- Size, location, tie-ins, and materials, along with proper maintenance, all affect the quality and quantity of water service delivered.
- For this reason, communities and water departments must consider the quality, capability, and reliability of new system installations and retrofits.
- The fire department should be consulted any time that modifications are made to a system to assure that fire department requirements are met, and that the system will supply enough pressure and quantity of water for fire protection purposes.

- The first fire mains in the Colonies were hollowed-out logs.
- Water mains today generally are constructed out of cast iron, ductile iron, steel, cement asbestos, polyvinyl chloride (PVC), or a combination of these materials.
- Water mains usually have the larger diameter pipe closer to the water source.
- From that point to the end user, the size gradually decreases.

Valves

- Valves control the flow of water through the water distribution system.
- Valves are broadly divided into two categories:
  - indicating and
  - nonindicating.

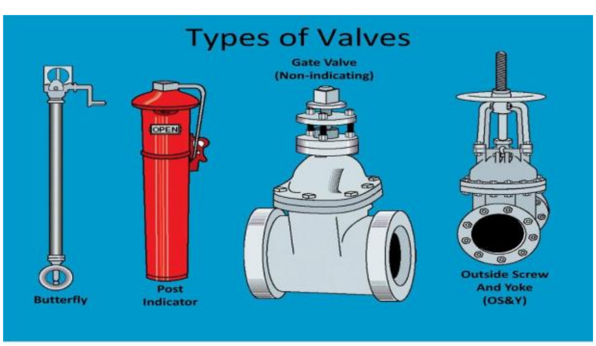
Indicating valves

- Indicating valves visually show the position of the gate or valve seat to indicate whether it is closed, partially closed, or open.
- The primary types of indicating valves used for connections to fire suppression systems are OS&Y (Outside Screw and Yoke), YPIV (Yard Post Indicating Valve), and indicating Butterfly Valves.
- Valves supplying water for fire protection and suppression systems should be chained and locked in the open position at all times.
- If not chained and locked, the valve should have a valve tamper alarm, which activates a trouble signal on an alarm system if the valve is not in the full open position.

Nonindicating valves

- Nonindicating valves do not have any visible means to show their position.
- Except for a few valves in plants and pumping stations, valves in water supply systems are of the nonindicating type.
- Valves in water distribution systems usually are buried or installed in manholes.
- When properly installed, a buried valve is operable from above ground through a valve box.
- A long-handled wrench, known as a "T" wrench, is inserted in the valve box to operate the valve.
- It is very important that valves are in the full open position, as a partially closed valve will not deliver the amount of water needed for the system and can hamper or even cripple firefighting operations.

- Valves should be tested at least once a year to assure their proper operation.
- Valves should be spaced so that only a short length of pipe will be out of service at one time should a break occur.



Fire Hydrants

Hydrants

- Early methods of obtaining water for firefighting purposes were crude.
- Water systems used hollowed-out logs for water mains.
- Pits were dug at specified intervals to expose the mains.
- A hole was made in the main and a wooden plug was inserted.
- These plugs were known as "fire plugs," and this term is still sometimes used to identify hydrants.
- When a fire occurred, the wooden plug was removed from the main, water filled the pit, and fire apparatus drafted from the pit.
- However, the flow of water was so meager that the system was seldom effective.

- Cast iron pipe permitted the system pressure to be increased, and this led to the development of the post-type fire hydrant.
- An opening at the upper end of the standpipe provided a place for the fire pumpers to receive their supply.
- Two basic types of fire hydrants used today are
  - dry barrel and
  - wet barrel.

Dry Barrel Hydrants

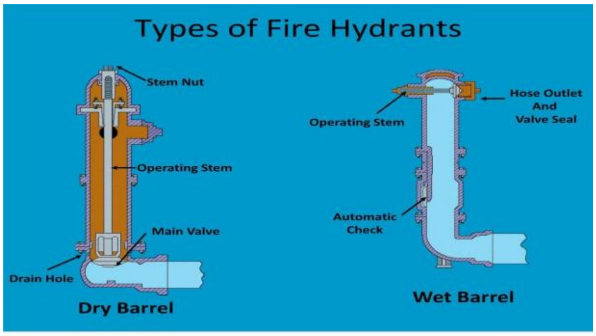
- Dry barrel hydrants operate with a valve at the bottom of the hydrant that opens at the water main and, when closed, permits the water remaining in the barrel to drain out.
- These hydrants are common in areas subject to freezing weather conditions and are by far the most common hydrants today.
- Current dry-barrel hydrant designs incorporate a traffic safety flange and operating rod installed just above grade.
- With this type of design, if a vehicle hits the hydrant, it will shear the hydrant and operating rod and allow the main valve to remain closed.
- The safety flange allows a new hydrant to be installed without digging down to the water main; this provides for less expensive repair and decreases time out of service.

Within the dry barrel option, there are:

- **Slide-gate:** The main valve moves vertically with a threaded system. When you rotate the stem, the internal gate moves. A wedging gate also moves against the valve at the base of the hydrant.
- **Toggle:** The main valve moves horizontally inside the hydrant base. The vertical stem contains both right and left-handed trash, allowing the valve to move. Rotating the stem causes the toggle arms to move the valve.
- **Compression:** When the nut is rotated, the stem moves up and down, opening or closing the valve, respectively.

Wet barrel hydrants

- Wet barrel hydrants may have a valve at each outlet or they may have only one valve that controls the flow to all outlets.
- In general, hydrant bonnets (tops), barrels, and foot pieces are made of cast iron.
- The important working parts usually are made of bronze, but the valve facings may be made of rubber, leather, or composition material.
- A standard hydrant is equipped with one large opening (4 inch or 4-1/2 inch) and two outlets for 2-1/2-inch hose couplings.
- Hydrant outlet threads must conform to the threads which the local fire department uses.
- National Standard hose coupling threads are best suited for mutual-aid operations.
- Adapters may be necessary when using hydrants in other response areas or those on private systems.



Wet barrel Hydrant Vs. Dry barrel Hydrant

Wet Hydrant or Wet Barrel Hydrant	Dry Hydrant or Dry Barrel Hydrant
Wet Hydrants are used where water-freezing issues are not present	Dry barrel hydrants are used in cold regions where the temperature routine drops below water freezing temperature.
In the wet hydrant design, the water is placed aboveground	The water in the dry barrel design is kept below ground to avoid freezing.
A wet Hydrant is easier to construct and cheap.	On the other hand, dry barrel hydrants are costlier and difficult to construct.
Maintenance of wet barrel hydrants is easier due to easy access.	Maintenance is comparatively difficult.

Fire Hydrants Color Coding

- The color coding of fire hydrants provides important information about the water supply's flow rate and pressure.
- It helps firefighters make quick decisions about which hydrants to use, especially in emergencies.
- Color coding can vary by country and even within regions of the same country.
- Still, the following is a general overview based on the National Fire Protection Association (NFPA) standards used in many parts of the U.S.:

Color	GPM	Flow Information
Blue	1,500 GPM or more	Very good flows
Green	1,000 to 1,499 GPM	Good for residential areas
Orange	500 to 999 GPM	Marginally adequate
Red	Below 500 GPM	Inadequate

ADVANTAGES OF FIRE HYDRANT SYSTEM

- A fire hydrant system is an effective means of extinguishing a fire in a building that can result in heavy devastation.
- The system can fight the fire from a long distance with its piping system.
- As it covers each point of the building, it has more penetration capability as compared to other fire protection systems.
- Hydrant valves are established at various places throughout the building, leaving no corner on the premises unprotected.

DISADVANTAGES OF FIRE HYDRANT SYSTEMS

1. The main disadvantage of Fire Hydrant System is that it has to be manually activated.
2. The flow of the Fire Hydrant System is so powerful; two men are required to hold the water hose.
3. A Fire Hydrant System, may cause damage to the tools or machines.
4. A Fire Hydrant Systems are very popular and, Customers search only for Fire Hydrant Companies or Fire Hydrant System Suppliers, but the main thing to understand is that it may not be the most efficient system.

5. In a fire hydrant system, an immense quantity of water is pumped out from the water tank with such a force and speed so that it can get the fire-affected area.
6. The capacity of these water tanks depends on the size and floor area of building like residential, commercial, or industrial.
7. The performance of a hydrant system depends on the quality and efficiency of the elements used to design the system.
8. This system needs inspections and tests at the regular interval of time to determine the system is working in proper way.

Water-Based Fire Protection Systems are

- Standpipe and hose system
- Fire Sprinkler system
- Water spray fixed system
- Water mist system

STANDPIPE AND HOSE SYSTEM

- *Standpipe as* an arrangement of piping, valves, hose connections, and associated equipment installed in a building or structure, with the hose connections located in such a manner that water can be discharged in streams or spray patterns through attached hose and nozzles, for the purpose of extinguishing a fire, thereby protecting a building or structure and its contents in addition to protecting the occupants.

Hose System is a combination of

- **Hose Station:** A combination of a hose rack or reel, hose nozzle, hose, and hose connection.
- **Hose Connection:** A combination of equipment provided for connection of a hose to the standpipe system that includes a hose valve with a threaded outlet.

- A standpipe and hose system is a simple system.
- It just delivers water during fire emergency.
- Three things to build a standpipe and hose system.
  - Pressurized water source
  - Pipe network
  - Hose stations

Pressurized water source

- *A pressurized water source* can be a municipal water hydrant line.
- Where it is not available or feasible, use a set of fire pumps.
- Flow and pressure requirements dictate the selection of a fire pump set for every individual project.
- Hydraulic calculation software is very useful for calculating flow and pressure in a complex project.

Pipe network

- *A pipe network* is a vital part of the standpipe and hose system which connects water source with hoses.
- It can be vertical or horizontal.
- Not only hose stations, but a pipe network also may contain Fire Hydrants, monitors, Fire Department Connection (FDC), isolation, and various types of valves.

Hose station

- Hose station as defined above can consist of hose reel or hose pipe or combination of both.
- It may contain 3 types of standpipes.

CLASSES OF STANDPIPE SYSTEM

Class I System

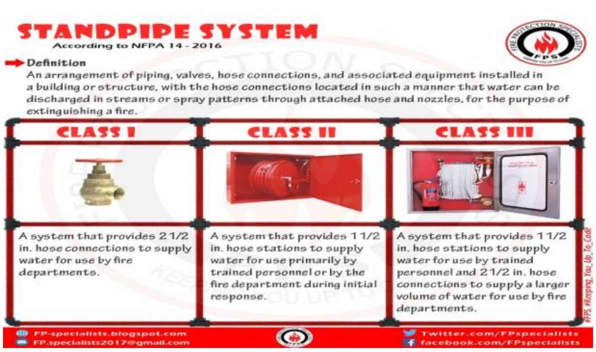
- It provides 2 1⁄2 in. (65 mm) hose connections to supply water for use by fire department firefighters only during an emergency.
- In this class, there are no hosepipes attached, only landing valves.
- So the fire department usually carries hose packs with them.
- Usually 2 1⁄2 in. landing valve installed within the landing area of stairways of buildings.
- This system requires high water pressure (at least 6.9 bar) and flow (at least 250 USGPM) makes it hard to control for an untrained people.

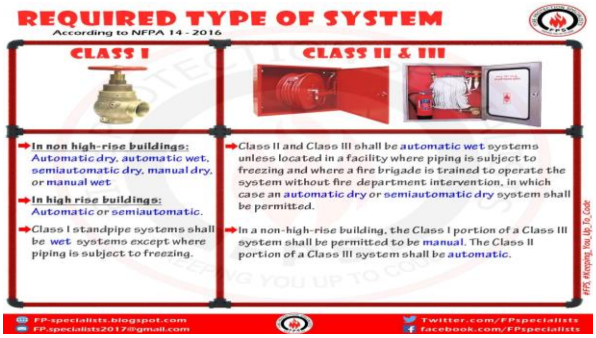
Class II System

- It provides 1 1⁄2 in. (40 mm) hose stations are often located in hallways of buildings to supply water for use primarily by trained personnel or by the fire department during initial response.
- It features permanently-installed 1.5" hoses in a cabinet that can be accessed by anyone in the event of a fire.
- This hose is normally found 100ft (30m) in length.

Class III System

- It is a hybrid of Class I and Class II systems.
- It provides 1 1⁄2 in. (40 mm) hose stations to supply water for use by trained personnel and 2 1⁄2 in. (65 mm) hose connections to supply a larger volume of water for use by fire departments.
- Often times these connections provide a 2-1/2 inch reducer to a 1-1/2 hose connection.




REQUIRED TYPE OF SYSTEM
According to NFPA 14 - 2016
CLASS I
CLASS II & III
In non high-rise buildings:
Automatic dry, automatic wet, semiautomatic dry, manual dry, or manual wet
In high rise buildings:
Automatic or semiautomatic.
Class I standpipe systems shall be wet systems except where piping is subject to freezing.
Class II and Class III shall be automatic wet systems unless located in a facility where piping is subject to freezing and where a fire brigade is trained to operate the system without fire department intervention, in which case an automatic dry or semiautomatic dry system shall be permitted.
In a non-high-rise building, the Class I portion of a Class III system shall be permitted to be manual. The Class II portion of a Class III system shall be automatic.
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FLOW RATE REQUIREMENTS
According to NFPA 14 - 2016
CLASS I & III
CLASS II
Minimum flow rate for the hydraulically most remote standpipe shall be 500 gpm, through the two most remote 2 1/2 in.outlets.
Where a horizontal standpipe supplies three or more hose connections on any floor, the minimum flow rate for the hydraulicallymost demanding horizontal standpipe shall be 750 gpm.
The min. flow rate for additional standpipes:
For buildings not exceeding 80,000 ft2 floor area: 250 gpm per addetional standpipe.
For buildings exceeding 80,000 ft2 floor area: 500 gpm for the second standpipe and 250 gpm for the third standpipe
The maximum flow rate shall be 1000 gpm for sprinklered buildings, and 1250 gpm non-sprinklered buildings
Min. flow rate for the hydraulically most remote hose connection shall be 100 gpm
Additional flow shall not be required where more than one hose connection is provided.
Note that:
Maximum flow rate required for individual 2 1/2 hose connection shall be 250 gpm, and for 1 1/2 hose connection shall be 100 gpm
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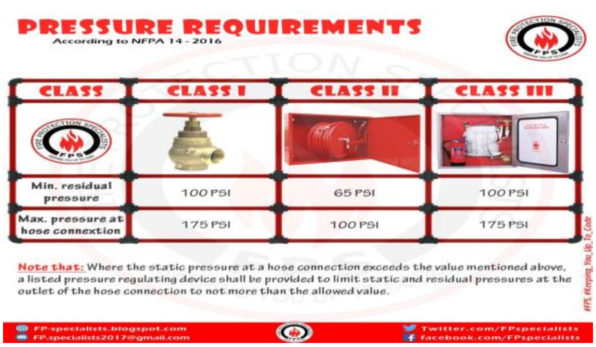
PRESSURE REQUIREMENTS
According to NFPA 14 - 2016
CLASS
CLASS I
CLASS II
CLASS III
Min. residual pressure
100 PSI
65 PSI
100 PSI
Max. pressure at hose connextion
175 PSI
100 PSI
175 PSI
Note that: Where the static pressure at a hose connection exceeds the value mentioned above, a listed pressure regulating device shall be provided to limit static and residual pressures at the outlet of the hose connection to not more than the allowed value.
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The design of the standpipe system depends on

- Building height
- area per floor
- occupancy classification
- egress system design
- required flow rate
- residual pressure
- the distance of the hose connection from the source(s) of the water supply

- The maximum pressure at any point in the system at any time shall not exceed 350 psi (24 bar). The pressure at a 1 1⁄2 in. (40 mm) hose outlet should not exceed 100 psi (6.9 bar) and for 21⁄2 in. (65 mm), not more than 175 psi (12.1 bar).
- Hydraulically designed standpipe systems shall be designed to provide the minimum water flow rate of 250 USGPM (946 LPM) at a minimum residual pressure of 100 psi (6.9 bar) at the outlet of the hydraulically most remote 21⁄2 in. (65 mm) hose connection and 250 USGPM (946 LPM) at 65 psi (4.5 bar) at the outlet of the hydraulically most remote 1 1⁄2 in. (40 mm) hose station.

SYSTEM INSTALLATION:

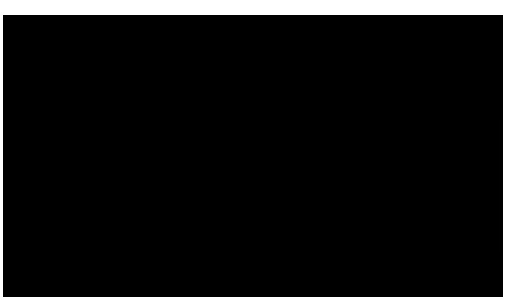
- Hose connections and hose stations shall be unobstructed and shall be located not less than 3 ft (0.9 m) or more than 5 ft (1.5 m) above the floor.
- This dimension comes from the measurement from the floor to the center of the hose valve.
- In each required exit stairway, we should use separate standpipe.
- Each standpipe can cover a travel distance of 200 ft (61 m) for sprinklered buildings and 130 ft(39.7 m) for nonsprinklered buildings.
- The standpipe must cover the accessible roof of a building.
- Standpipes shall be at least 4 in. (100 mm) in size.
- If it is a combined system (Standpipe plus Sprinkler) then it should be at least 6 in. (150 mm) in size.

FIRE PUMP CAPACITY FOR STANDPIPE SYSTEM

No of Riser	No of Standpipe	No of most remote 21/2 in. (65 mm) outlets	Pump flow capacity in USGPM
1	1	2	500
2	2	3	750
3	3	4	1000
4	4	5	1250

References to follow for standpipe system design and installation

- NFPA 14: Standard for the Installation of Standpipe and Hose Systems
- NFPA 24: Standard for the Installation of Private Fire Service Mains and Their Appurtenances
- NFPA 20: Standard for the Installation of Stationary Pumps for Fire Protection
- NFPA 25: Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems



WATER SPRAY FIXED SYSTEM

- Water Spray System is an automatic or manually actuated fixed pipe system connected to a water supply and equipped with water spray nozzles designed to provide a specific water discharge and distribution over the protected surfaces or area.

- A water spray fixed system sometimes called a deluge system is a total flooding system.
- Therefore, its operation differs from the sprinkler system.
- A sprinkler system is only activated when it reaches its predefined or rated temperature, most of the cases it is one sprinkler at a time.
- But in this system, a detection system triggers a zone of spray nozzles.

- Apart from a pumping unit and a pipe network, a water spray fixed system consists of the following
  - Nozzle
  - Deluge or Actuating type Butterfly valve
  - Quartzoid Bulb sprinkler/other detection systems

WHEN TO SELECT WATER SPRAY SYSTEM

Normally, the system can attain any one of or a combination of the following objectives :

- *Extinguishment of fire:* generally used for Cable Trays and Cable Runs, Belt Conveyors, etc.
- *Control of burning:* For Pumps, Compressors, and Related Equipment and Flammable and Combustible Liquid Pool Fires.
- *Exposure protection*: For vessels, Structures, and Miscellaneous Equipment, Transformers, etc.
- *Prevention of fire*: For dissolving, diluting, dispersing, or cooling of flammable vapor, gases, or hazardous materials.

SYSTEM DESIGN

- Fixed spray Systems should operate automatically with the presence of supplementary manual tripping means.
- If a system is isolated and attended 24/7 by trained personnel than the only manual operation is ok.
- The system design should work in such a way through water spray from all open nozzles operate without delay.
- The nozzle spray pattern definitely needs to overlap. Nozzle spacing (vertically or horizontally) shall not exceed 10 ft (3 m) or it can if the nozzle is listed otherwise.

SIZE OF SYSTEM AND WATER DEMAND

- A single system shall not protect more than one fire area.
- The hydraulically designed discharge rate for a single system or multiple systems designed to operate simultaneously shall not exceed the available water supply.

The following factors determine the number of systems expected to operate simultaneously:

1. The possible flow of burning liquids between areas before or during operation of the water spray systems
2. The possible flow of hot gases between fire areas that could actuate adjoining systems, thereby increasing demand.
3. Flammable gas detection set to automatically actuate systems
4. Manual operation of multiple systems
5. Other factors that obviously result in the operation of systems outside of the primary fire area

Generally, hydraulic calculation is used as part of the design of the piping system to determine that the required pressure and flow are available at each nozzle.
The minimum operating pressure of any nozzle protecting outdoor hazard shall be 20 psi (1.4 bar).

References to follow for Water Spray Fixed System

- **NFPA 15:** Standard for Water Spray Fixed Systems for Fire Protection
- **NFPA 14:** The standard for the Installation of Standpipe and Hose Systems
- **NFPA 24:** The standard for the Installation of Private Fire Service Mains and Their Appurtenances
- **NFPA 20:** The standard for the Installation of Stationary Pumps for Fire Protection
- **NFPA 25:** The standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems

Sprinkler System

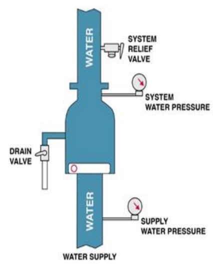
Sprinkler System

Types of sprinkler systems permissible by NFPA

- Wet,
- Dry,
- Preaction, and
- Deluge.

Wet Pipe Systems

- Wet pipe sprinkler systems are the most common.
- In this system the sprinkler piping is constantly filled with water.
- When the temperature at the ceiling gets hot enough the glass bulb or fusible link in a sprinkler will break.
- Since the system is already filled with water, water is free to flow out of that sprinkler head.



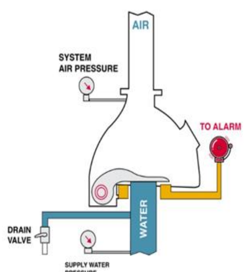
- The temperature around that specific sprinkler head needs to be high enough to break the glass bulb or fusible link that is holding water back.
- Once that happens, water will immediately start flowing from only that head.
- Wet pipe sprinkler systems are the most reliable and cost effective.
- Therefore, they should be the first type considered when selecting a sprinkler system.
- However, there are times when a wet pipe sprinkler system may not be appropriate.

- One of the major factors in determining if a wet pipe system can be used is the temperature of the space to be protected.
- Will all areas of the building where the sprinkler piping is located be conditioned to at least 40^{0}F (4^{0}C) or greater? If the answer is yes, then there is no risk for the water in the piping to freeze and a wet system is the preferred method.
- However, if the answer is no, an additional study may need to be done to determine if an engineer can prove that although the temperature could drop below 40^{0}F (4^{0}C) it will never drop low enough for the water to freeze.
- If the temperature of the space cannot be guaranteed to eliminate the risk of freezing water, then a different system type should be chosen.

- Wet pipe fire sprinkler's pipes contain water and are the most common type of fire sprinkler system.
- Since water is present in the system, facilities must maintain a temperature of at least 4 degrees.
- This prevents the water in the pipes from freezing.
- The process to activate a wet pipe fire sprinkler is simple.
- When a fire sprinkler element reaches a designated temperature, it breaks and releases the water.
- Wet pipe fire sprinkler systems are found in office buildings, schools, and high-rise buildings with ordinary hazards.

Dry Pipe Systems

- Dry pipe systems are very similar to wet pipe systems with one major difference.
- The pipe is not constantly filled with water.
- Instead, the water is held behind a dry pipe valve usually some distance away from where the sprinklers are located.
- Like a wet pipe system, when the temperature at the ceiling becomes hot enough, the glass bulb or fusible link of the sprinkler breaks.



- However, in this case, water isn't immediately available because the pipe is not water filled.
- Instead, air is released from the now open sprinkler head.
- This creates a drop in pressure causing the dry pipe valve to open and water to fill the system.
- Water will then flow from the open sprinkler head.
- Since there is a delay between sprinkler operation and water flow, the size of dry pipe systems is limited.
- The size limitation is intended to minimize the amount of time water delivery is delayed.
- A dry pipe system is a great option for unconditioned spaces, or locations where the temperature of the space cannot be guaranteed to be high enough to prevent water in the system from freezing.

- It is important to note that a least the portion of the building where the water comes in and the dry pipe valve is located will need to have temperatures hot enough to prevent freezing.

- Unlike wet pipe systems, dry pipe fire sprinklers are filled with nitrogen or pressurized air.
- The air pressure holds a dry pipe valve closed and prevents water from entering the system.
- When a fire sprinkler detects a sudden temperature increase it activates and the air pressure drops in the system.
- This causes the dry pipe valve to open and floods water into the dry pipe fire sprinkler system.
- Then the activated fire sprinkler discharges the water.
- Since dry pipe fire sprinklers contain no water, they're ideal in areas subject to freezing temperatures.
- Unheated warehouses, parking garages, and attic spaces often utilize this type of fire protection system.

Preaction Systems

- Of all the sprinkler system types perhaps the most complicated is the preaction system.
- There are three different types of preaction systems,
  - a non-interlock system,
  - a single interlock system, and a
  - double interlock system.
- The main difference between preaction systems and wet and dry pipe systems is that a specific event (or events) must happen before water is released into the system.

- This might sound similar to a dry pipe system, but the differences lie in what event triggers the release of the water:
  - For a non-interlock system: the operation of detection devices **OR** automatic sprinklers
  - For a single interlock system: the operation of detection devices
  - For a double interlock system: the operation of detection devices **AND** automatic sprinklers
- To better explain how these types of systems work, we'll walk through an example using a room that is protected with sprinklers fed from a preaction system.
- In addition to sprinklers, the room has complete automatic heat detection.

- Typically, the detection system, will have a lower temperature rating than the sprinklers.
- This will help ensure that the detection system activates before a sprinkler head operates.
- In this case, heat detectors that have a rating of 135^{0}F will serve as our detection system, and the sprinklers will have a temperature rating of 165^{0}F.
- In a non-fire event, such as accidental damage to a sprinkler head that results in the glass bulb breaking, the system would fill with water in a non-interlock system, and water would flow from the broken sprinkler head.

- The same situation in a single interlock preaction system would not result in waterflow because the broken glass bulb will not trigger the system to be filled with water.
- Only the operation of detection devices will result in a water filled system for a single interlock system.
- In the same room, the non-interlock and single interlock systems operate very similarly if there was a fire event.
- The heat detectors should activate first since they have a lower temperature rating.
- For both a non-interlock and a single interlock system, the activation of the heat detectors would result in the system filling with water.
- Then, if the temperature continues to rise, a sprinkler will operate.

- Since the "event", heat detection, has already happened, the system is filled with water, and we would expect it to act like a traditional wet pipe system.
- In this same situation, a double-interlock system will not fill with water upon the activation of the heat detection.
- Instead, the system will only fill with water after the activation of the heat detection system and the operation of a sprinkler head.
- Therefore, a delay in water delivery similar to what is seen for dry pipe systems will occur.
- For this reason, double interlock preaction systems have similar size restrictions as dry pipe systems, whereas non-interlock and single interlock are just limited to 1000 sprinkler heads per preaction valve.

Single Interlock

- Single interlock preaction systems work nearly the same as a dry fire sprinkler system, with the exception of the preceding fire detection event.
- Where a dry system will only actuate once heat or fire is detected, single interlock systems respond a bit more quickly, by responding to the activation of a smoke detector or fire alarm.
- This decreases the time delay associated with dry fire sprinkler systems.

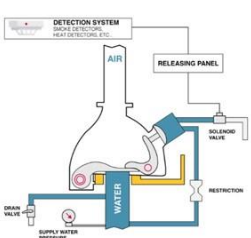
Double Interlock

- Double interlock preaction systems require a preceding fire detection event just like a single interlock system.
- What sets them apart is that they also require the operation of an automatic sprinkler system.
- Both systems have to be activated — the sprinklers and the smoke detector — before the double interlock preaction fire sprinkler system will release water into the system.
- Double interlock systems are best for sensitive environments where activation of the sprinkler system can cause significant damage.
- If there's some sort of mechanical failure or false alarm — a sprinkler head is damaged, a pipe breaks, a natural disaster occurs — the system will not actuate, helping to keep the valuable property within the building safe.

- Pre-action fire sprinkler systems contain pressurized air or nitrogen instead of water.
- Activating pre-action systems is a two-step process.
- First, a heat or smoke detector must detect a fire which then sends a signal to open the pre-action valve. This fills the system with water.
- Next, a fire sprinkler head must detect an increased temperature to indicate a fire.
- Once, the fire sprinkler opens water immediately pours onto the fire.
- Pre-action fire sprinklers two-step activation process helps prevent accidental system activations.
- This makes these types of fire sprinkler systems ideal for applications such as museums, server rooms, libraries, and data farms.

Deluge systems

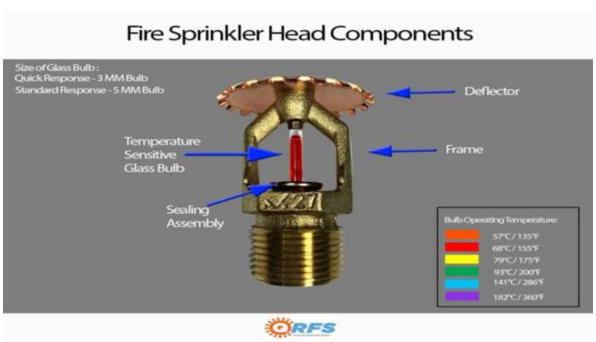
- Deluge systems are similar to preaction systems in that they use another type of detection for operation.
- However, the biggest difference is that deluge systems use open sprinklers or nozzles.
- Instead of getting water flow from individual heads that have operated, once water fills the system, water will flow from every sprinkler head.
- Much like a preaction system, a deluge valve will keep water from filling the system until the operation of another type of detection system, such as smoke detection.
- Once that detection system is activated, water not only fills the system but flows from the open sprinklers or nozzles.



- Another consideration in the selection of the type of sprinkler system is the level of hazard being protected.
- If protecting an area of very high hazard, such as aircraft hangers, a deluge system may be the most suitable.

- High hazard facilities utilize deluge fire sprinkler systems since the open style sprinkler heads can discharge water quickly.
- Unlike the other types of fire sprinkler systems, these sprinkler heads always remain open and activate all at once.
- These systems also contain no water nor pressurized air. Once a heat or smoke detector detects smoke or heat, the deluge valve opens and sends water to all the fire sprinklers.
- This allows water to discharge from each sprinkler head.
- When highly combustible material catches on fire the flames can grow and spread immediately.
- That's why facilities like aircraft hangars, industrial plants, and manufacturing companies need a fast-acting deluge fire sprinkler system.

- Each system type has its own unique benefits.
- It is important to consider the pros and cons of each system type when selecting which sprinkler system is appropriate for your specific environment.
- An entire building may be protected with a combination of systems.
- For example, one of the more common designs in the Northeast is to protect the portions of the building that are conditioned with a wet pipe system and to use dry pipe systems in the attic and other unconditioned areas.
- Combining different types of systems for full building protection allows the designer to consider each unique environment and apply the most appropriate system type to that space without sacrificing what is best for other areas of the building.



Temperature Rating		Color of Fluid Within Bulb	
Celcius	Fahrenheit		
57	135	Orange	
68	155	Red	
79	174	Yellow	
93	200	Green	
141	286	Blue	
182	360	Mauve	
227 / 260	440 / 500	Black	

1.Pendent Sprinkler Heads
- Hangs down from the ceiling
- Sprays water downward in circular pattern to maximize coverage
- Ideal for offices, hotels, and factories etc.

2.Concealed Pendant Heads
- Are located within the ceiling and are hidden by a cover plate
- Works similar to a pendent sprinkler head after the cover plate falls off once it reaches 20˚F lower than fire sprinkler temperature
- Ideal for places where aesthetic is a concern

3.Upright Sprinkler Heads
- Stands upright
- Sprays water upward in a hemispherical pattern
- Useful in buildings with exposed ceilings like mechanical rooms or hard to reach places like beams and ducts

4. Side Wall Sprinkler Heads
- Mounted on the side of wall, only have half of a deflector
- Sprays water in half circle/crescent shape
- Great for small rooms, hallways, and places sprinkler pipes run up walls


Foam Fire Extinguishing System



Foam Fire Extinguishing System

- The "foam" in foam fire suppression systems is an extinguishing agent that can extinguish flammable or combustible liquid by cooling and separating the ignition source from the surface.
- The foam suppresses and smothers fire and vapors alike.
- It can also prevent reignition.
- It is also known as "firefighting foam."
- This foaming agent is made up of small air-filled bubbles that have a lower density than water.
- Foam is made up of water, foam concentrate, and air.
- Different manufacturers have their own foam solutions and concentrate.
- The proportion of foam to water depends on the application.

- Foam extinguishing systems use foam monitors, sprinklers or nozzles to create large-scale foam blankets that cover the burning material, put out the fire and prevent it from re-igniting.
- Foam extinguishing systems are ideal for protecting high-risk areas, such as those with flammable liquids or plastics.
- The foam can be adjusted from low to very high expansion, depending on the type of risk, to achieve the best extinguishing effect.

How does foam suppression systems put out fires?

- Foam suppression systems are used to "cool the fire and coat the fuel that the fire is consuming to prevent contact with oxygen and reduce combustion ability."
- The foam, when dispersed, smothers or blankets the surface of the fuel.
- The water content of the foam then cools the fuel and the area of foam covering the fuel to prevent reignition via flammable vapors.

- Foam suppression systems are designed much like a wet sprinkler system in that stored water flows through a network of pipes where it is then discharged through nozzles.
- The main difference with foam systems and other traditional wet sprinkler systems is the addition of the foaming agent.
- This foaming agent is stored separately from the water and the two are mixed within the piping system prior to discharge.
- At the end of the piping is a nozzle.
- The foaming agent is added or ejected into the water at the very last moment before discharge.
- When the water mixes with the foaming agent, expansion occurs and creates an immense coverage of foam to fill expansive areas.

- Foam suppression systems are usually in large areas where there is a lot of flammable or combustible liquids such as Warehouses, Marine Applications, Flammable liquid storage, Jet engine testing facilities and aircraft hangars.
- The foam system is most commonly used in these areas is because of the capabilities of foam to not only extinguish but also smother flames in a way that prevents reignition.
- Special hazard fire suppression systems can provide highly effective and reliable protection when water-based systems are just not enough.

- Whether it be highly flammable materials, data centers, pharmaceutical, industrial, commercial, military, or protection of priceless commodities, a special hazard fire protection system may be the right solution to protect your assets.
- These systems require precision, specialized understanding, and careful engineering to meet industry standards and perform properly when needed most.

Foam Fire Extinguishing System is divided into two categories

Air Foam Fire Extinguishing System

- Being intended primarily for Flammable Liquids, Air Foam Fire Extinguishing System is installed at agencies, producers and storage site of explosives and combustibles.

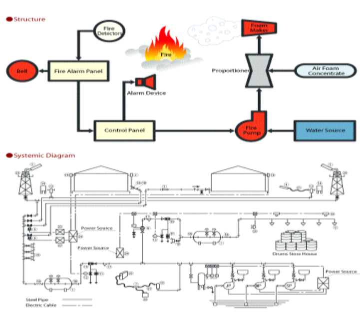
Chemical Foam Fire Extinguishing system

- Chemical Foam Fire Extinguishing System is considered obsolete and has generally been replaced by Air Foam Fire Extinguishing System.
- The system comprises Water Source, Fire Pump, Air Foam Concentrate, Proportioner, Foam Maker, Foam Dischange Outlet Control Panel, Pipe, Electric Wire, etc.

Air Foam Concentrate

- Air Foam Concentrate is made into a fixed ratio of Air Foam Solution by mixing with water flowing through Feed Pipe and is mechanically stirred by Foam Maker which sucks air and generates great deal of Air Foam to extinguish a fire involving flammable liquids with smothering and cooling effect.
- Air Foam Concentrate makes fine foams with excellent stability and thermal resistance, and freely flows and develops on liquid surface such as petroleum to promptly extinguish a fire.
- It also sticks firm to a solid surface, level or vertical, to prevent the fire from spreading.

- Of the Fixed Air Foam Fire Extinguishing System, Air Foam Chamber and Subsurface Foam Injection are intended mainly for extinguishing a fire set on Exterior Storage Tanks, and Air Foam Spray Head for Flammable Liquid Hazards.
- Air Foam Nozzle is used as Supplemental Air Foam Hydrant for Exterior Storage Tanks or as Air Foam Hydrant for Flammable Liquid Hazard.
- Air Foam Monitor Nozzle is provided near the inlet port of Exterior Storage Tanks and particularly on a quay or a pier for extinguishing a fire set on oily outflow on the sea.



Types of Firefighting Foam

Types of Firefighting Foam

- Low expansion form
- Medium expansion form
- High expansion form

- Class A
- Class B

Low expansion foam

- Low expansion foam grows up to 20 times its liquid size and can flow far for long distance use.
- This foam sticks well and is dense, so high wind conditions do not affect it much, making it very effective outdoors, such as on helipads and ships.
- It can moisten solid surfaces and also protect them by forming a thick foam layer that cools and blocks vapors.

Medium expansion foam

- Medium expansion foam grows from 20 to 200 times its liquid size.
- It has similar properties to low expansion foam, but it can create a bigger blanket.
- However, it is not as dense, so high wind conditions can affect it more in an outdoor application.

High expansion foam

- High expansion foam grows more than 200 times its liquid size and uses more air and less water.
- It makes big bubbles fast and makes a deep layer of fire-fighting foam.
- These applications are only for indoor use in places like aircraft hangers, warehouses, or enclosed rooms because they are very sensitive to wind.

Class A

- Class A firefighting foam is specifically formulated to combat Class A fires, which involve solid materials such as wood, paper, and textiles.
- It is commonly used in structural firefighting, wildland firefighting, and in situations where water alone may not be effective in extinguishing the fire.
- Class A firefighting foam is typically made from a mixture of surfactants, wetting agents, and stabilisers, which reduce the surface tension of water and allow it to penetrate deep into porous materials.
- The foam is mixed with water to create a solution that can be applied using firefighting equipment such as foam nozzles and foam cannons.

Examples of Class A Firefighting Foam

Protein-based Foam

- Made from natural proteins such as animal or vegetable proteins.
- Protein-based foams are highly effective for penetrating deep-seated fires and are commonly used in structural firefighting.

Synthetic-based Foam

- Made from synthetic materials such as synthetic surfactants and stabilisers.
- Synthetic-based foams are designed to produce a thick, stable foam blanket that can quickly extinguish fires and prevent re-ignition.

Film-forming foam (FFFP)

- A combination of Class A and Class B foam, FFFP foam forms a thin film on the surface of the fuel, preventing oxygen from reaching the fire and extinguishing it more quickly.

Class B

- Class B firefighting foam is specifically formulated to combat Class B fires, which involve flammable liquids such as gasoline, oil, and alcohol.
- It is commonly used in industrial, commercial, and military firefighting operations, as well as in situations where water alone may not be effective in extinguishing the fire.
- Like Class A firefighting foam, Class B firefighting foam is typically made from a mixture of surfactants, wetting agents, and stabilisers and allows it to form a blanket over the fuel, preventing oxygen from reaching the fire.
- The foam is mixed with water to create a solution that can be applied using firefighting equipment such as foam nozzles and foam cannons.

Examples of Class B Firefighting Foam

Aqueous film-forming foam (AFFF)

- AFFF foam forms a thin film on the surface of the fuel, preventing oxygen from reaching the fire and extinguishing it more quickly.
- It is one of the most common types of Class B firefighting foam and is widely used in industrial and commercial firefighting operations.

Alcohol-resistant aqueous film-forming foam (AR-AFFF)

- AR-AFFF foam is specifically designed to combat fires involving alcohol-based fuels such as ethanol and methanol.
- It forms a thick, stable foam blanket that can quickly extinguish the fire and prevent re-ignition.

Fluoroprotein foam

- Fluoroprotein foam is a protein-based foam that contains fluorinated surfactants, which make it more effective for extinguishing fires involving hydrocarbon fuels.
- It is commonly used in aviation firefighting and in situations where Class B fires are likely to occur.

- Rapid Fire Suppression
- Versatility
- Reduced Water Usage
- Increased Visibility
- Long Lasting
- Cooling Effect

- Environmental Impact
- Health Concerns
- Clean-up and Disposal
- Cost
- Training and Equipment

- Water
- Dry Chemical Agents
- Carbon Dioxide (CO_2)
- Foam-Water Sprinkler Systems
- Fire Blankets

Water spray systems

- A Water Spray System for Fire Protection a different variant of the Fire Sprinkler System.
- Such a system is used in places where a fire is likely to spread out of control within a short duration rapidly.
- Examples of such places where Water Spray System for Fire Protection are required are:
  - Transformers,
  - Compressors,
  - Condensate Storage Tanks,
  - LPG bullets and
  - Combustible fuels.

Is it compulsory to have/install, Water Spray System for Fire Protection?

- It depends on the type of system, equipment or inflammable liquid in use. Suppose you are using any highly inflammable substance, combustible or catch fire and spread quickly.
- This system is a mandate for you.

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How it works???

- In an oil-cooled transformer, the oil is likely to catch fire after a certain temperate is exceeded, and instantly the entire transformer will catch fire and burn from all sides, even though the transformer is made up of metal.
- To avoid this kind of fire, Water Spray System can be used.

- There may be multiple metal rings of detectors; a detector is nothing but a temperature sensing element.
- This detector ring is placed next to the most likely spots where the temperature is about to exceed or fire is about to occur.
- Also, the entire transformer is surrounded by multiple sprays at multiple levels.
- A spray is nothing, but a sprinkler without the temperature sensing, bulb.
- When the fire does occur, the detector ring detects this; and gives the signal to the deluge valve or all the sprinkler surrounding the transformer to start all at once.
- Hence the entire transformer is flushed with water to cool it down.

- Water Spray System is a special fixed pipe system connected to a reliable source of pressurised water supply and equipped with water spray nozzles for application on area / equipment to be protected.
- The system can be operated automatically by connection to an automatic detection and alarm system or manually, or both.
- Water spray systems are generally used for fire protection of flammable liquid and gas storage tanks, piping, pumping equipment, electrical equipment such as transformers, oil switches, rotating electrical machinery etc. and for protection of openings in fire walls and floors.
- The piping system is connected to the water supply through an automatically actuated Deluge Valve, which initiates flow of water.

- Automatic actuation is achieved by operation of automatic detecting equipment installed along with water spray nozzles.
- There are two types of systems namely High Velocity and Medium Velocity systems.

Medium Velocity Water Spray Systems (MVWSS)

- Medium Velocity Water Spray Systems (MVWSS) are used for fire protection of areas with fire risks from low FP flammable liquids (FP below 65 ^{0}C) and also for fire extinguishment of water miscible liquids (polar solvents, alcohols etc.) small installation as it becomes cost effective and also serves the purpose of safety and location identification is easy.
- MVWS is generally used in oil-based systems, having low flashpoints.
- The water sprays' velocity, hitting the system under fire, if it is high, might actually spread the fire and not extinguish it.
- Hence, the velocity of the water has to be in range.

- Fires on Hydrocarbon are more frequent due to the hydrocarbon's volatility and its property to not dissolve with water and lighter than water the fire extinguishing of hydrocarbon fire with water is not possible.
- In case of fire on Hydrocarbon, if the water is sprayed, due to the hydrocarbon's lightweight, it will float on the water and reignite them to fire and due to the water's speed, the fire will travel from one place to another place.
- However, these plant water spray system can be provided as exposure protection.
- That means if any plant is under fire, the plants nearby shall be kept cool with the water spray system, while the plant under fire shall be applied foam.

- Hence in this case, where a plant uses hydrocarbon, the exposure should be protected with a water spray system designed as per NFPA 15.
- This system is mostly used for the protection of the following:
  - Expander & Sale Gas Compressors
  - Off Gas Compressors etc.
- Quartzoid Bulb Sprinklers (Q. B. S.) Detection is used to detect fire, which will be connected to a deluge valve for the system's auto operation. Q B Sprinklers shall be of 68 Deg or 79 Deg C or any other temperature depending upon the ambient temperature of the plant's location.
- For the system's electronic automatic operation, the deluge valve shall be provided with pressure sensors, temperature sensors, and an annunciation panel.

- In case of fire, the Quartzoid Bulb sprinkler shall burst due to heat that allows water in the detection pipe to drain out and allow the Deluge valve to open fully.
- As soon as the Deluge valve opens, the water shall flow through the piping to flow water to all water spray nozzles mounted on the plant's ceiling.
- The water shall be sprayed in a solid conical spray pattern to cover the entire plant floor area so that the equipment installed shall be kept cool to avoid heat radiation and further ignition of the fire.
- The fire shall be control with the help of the water spray system.
- The indication of the operation of the system shall be available on the control panel with Alarming Siren.

Advantages of M.V. Water Spray System

- The entire area is flooded with foam, which is very useful for fire fighting in hazardous areas, plants, storage tanks, etc., where the manual approach is difficult.
- Very quick in response.
- The fire losses are kept low as the area under fire gets foam blanket and cooling due to water content, and so chances of spreading fire are negligible.

High Velocity Water Spray Systems (HVWSS)

- High Velocity Water Spray Systems (HVWSS) are used for extinction of fires in flammable medium and heavy oils or similar flammable liquids having a flashpoint above 65 ^{0}C. (E.g. Transformer Fires, Lube Oil Tanks, Etc).
- HVWS is generally used in oil-based systems, having high flashpoints.
- The water sprays' velocity, hitting the system under fire, is critical for successful fire extinguishing action.

- High-Velocity water spray systems are installed to extinguish fires involving liquids with 65 ^{0}C or higher flashpoints.
- Three principles of extinguishment are employed in the system – emulsification, cooling and smothering.
- The result of applying these principles is to extinguish the fire within a few seconds.
- This system is mostly used for the protection of the following.
  - Transformers, oil-filled types of equipment of power stations
  - Turbo-alternators and other
  - Oil fired boiler rooms, oil quenching tanks.
- Transformer protection shall contemplate on essentially complete impingement on all exterior surfaces except the underside, which may be protected by horizontal projection.

- Transformers present particular design problems for Water spray protection, primarily due to their irregular shape and necessary clearances for the high voltage equipment.
- Generally speaking, there is much more interference with the water flow on the transformer's sides than at their top.
- Due to this reason, the protection usually involves a large number of small capacity projectors than a few bigger ones.
- Often it will be necessary to put more water on the transformer than required to achieve complete impingement and total envelopment.

- All system components shall be so located as to maintain minimum clearances from live parts.
- "Clearance" is the air distance between Water Spray Equipment, including piping nozzles and detectors and un-insulated live electrical components at other than ground potential.
- The minimum clearance is 900 mm under normal conditions.
- During the operation of the Water Spray system, they are intended for use as safe.

- The nozzles shall be installed in rows around the transformer and above the oil condenser.
- Quartzoid Bulb Sprinklers (Q. B. S.) Detection is used to detect fire, which will be connected to the deluge valve for the system's auto operation.
- Q B Sprinklers shall be of 68 Deg or 79 ^{0}C or other temperatures depending upon the ambient temperature of the plant's location.

WATER CURTAIN SYSTEM

WATER SPRAY NOZZLES

- These are similar nozzles as sprinkler, but there is no bulb used, and they have an open orifice that could not hold the water pressure.
- These nozzles have a threaded inlet and deflector at the outlet and fitted on the pipe array-like sprinkler.
- This system spray water from all nozzles as the control valve gets open, and therefore the area under fire receive water.
- The adjacent area also gets water and reduces the chances of spreading the fire.

- The water spray system is basically most useful for various tanks storing hazardous liquids or chemicals.
- The system consists of a water reservoir, a pump of suitable capacity and pressure, delivery main and distribution pipe array, main control valve(known as deluge valve), water spray nozzle, and heat-sensing element.
- In a fire, the heat-sensing element, mainly bulb type sprinklers, burst when the rated temperature arrives and causes an open deluge valve due to pressure difference.
- The valve floods complete main and distributed pipes and starts spraying from all the water spray nozzles at a time.
- The spray remains under operation till the deluge valve is rest manually.
- This is the most reliable and suitable system for tank protection as well as exposure protection.

Advantages of Water Spray System

- The entire area is flooded with water, hence very useful for fire fighting in a hazardous area, basement, storage tanks, etc.
- Very quick in response.
- The fire losses are kept low as the area adjacent to the fire also gets water protection, so the chances of spreading fire are negligible.

Disadvantages of Water Spray System

- As the entire system gets flooded with water, the water damage is more.
- This system needs maintenance and periodic checking of automatic operation for reliability during a fire.

Water mist systems

Water mist systems

- When it comes to fire protection, traditional sprinkler systems have been used for a long time as the preferred method of containment and suppression.
- However, in recent years, water mist systems have begun to gain traction due to their superior fire suppression capabilities and versatility.
- A water mist system is an advanced special hazard solution that uses small water droplets to control, suppress, or extinguish fires.
- The system works by discharging high-pressure water through specialized nozzles that atomize the water and create a fine mist.

What is a Water Mist System?

- A water mist fire suppression system is an advanced special hazard solution that uses small water droplets to control, suppress, or extinguish fires.
- The system works by discharging high-pressure water through specialized nozzles that atomize the water and create a fine mist.
- This mist is able to absorb heat and displace oxygen, effectively controlling the spread and intensity of the fire.
- Water mist systems are classified by several characteristics, such as:
  - Operating pressure
  - Size of water droplets
  - Extinguishing agent
  - Design configuration

- Water mist systems are fire suppression systems that use very small water droplets to extinguish or control fires.
- These droplets are effective at controlling fires while using less water and having smaller piping than a standard sprinkler system due to the increased cooling effects, oxygen displacement and pre-wetting that the droplet size and distribution provide.
- Some additional benefits of water mist fire protection systems include reduced water damage and low environmental impact, while one of the trade offs include higher system pressure.

Operating Pressure

- According to NFPA 750, there are three distinct pressure classifications for water mist fire suppression systems:
  - low,
  - intermediate, and
  - high-pressure systems.
- The higher the pressure, the finer the mist created by the system.
  - **Low-Pressure Systems** - Under 175 psi
  - **Intermediate-Pressure Systems** - 175 to 500 psi
  - **High-Pressure Systems** - Over 500 psi

Size of Water Droplets

- The size of water droplets generated by the nozzles is critical to the effectiveness of a water mist fire suppression system.
- Smaller droplets create a finer mist, which increases the cooling effect on a larger surface area when they come into contact with flames.
- This helps reduce the spread of fire and limits any potential damage caused by it.
- smaller droplets are lighter than larger ones, allowing them to cover more space with less water used in the system.
- These features make high-pressure systems particularly effective at suppressing fires, as their nozzles generate extremely small droplets that are highly efficient at cooling flames down.

- The droplet size for water mist systems can vary between 1000 microns and 10 microns.
- This small droplet size decreases the required application rate, enhances evaporation, and helps reduce oxygen levels to extinguish visible and hidden fires.
- In order to be classified as a water mist system, water droplets should be less than 1,000 microns.
- For comparison, traditional fire sprinkler systems produce droplet sizes of around 5,000 microns.
- Droplet sizes produced by different water mist pressures:
  - **Low-Pressure Systems** - Under 1,000 microns (the thickness of a dime)
  - **Intermediate-Pressure Systems** - 300 to 500 microns
  - **High-Pressure Systems** - 50 to 100 microns

Extinguishing Agent: Single-Fluid or Twin-Fluid

Single-fluid water mist systems

- It uses one set of distribution piping and only water as the extinguishing agent.
- The mist is formed by passing water through a nozzle, creating tiny drops that promote rapid cooling and absorb heat from the environment.
- This type of system works best in smaller, enclosed areas because the particles may not be able to reach larger areas or travel too far before evaporating.

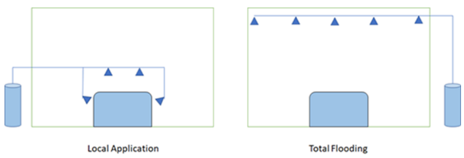
Twin-fluid water mist systems

- Its uses separate piping systems and a combination of water and another extinguishing agent, such as nitrogen or air, to create even smaller droplets.
- Twin fluid systems are often used for large area coverage and applications where precise control over the fire is necessary.

Design Configurations

- Water mist suppression systems are configured based on individual fire hazards and specific applications.
- Here are the four most common design approaches.
  - Local Applications
  - Occupancy protection systems
  - Total Compartments applications
  - Zoned applications

- **Local Application** - This configuration uses a small number of nozzles to discharge water mist directly onto a specific hazard or object.
- **Total Compartment Application** - The nozzles in this configuration activate at the same time to provide uniform coverage throughout entire rooms or compartments within a building. They are typically used in high-hazard areas where there is a greater risk of fire, such as server rooms or chemical storage areas.



- **Occupancy Protection Systems** - This configuration uses a larger number of automatic nozzles to protect an entire facility or a portion of a facility.
- **Zoned Application** - This configuration is similar to occupancy protection systems, but they are designed to protect specific zones or areas within a building. This allows for more targeted protection in areas where the risk of fire may be higher while also minimizing the amount of water required to suppress the fire.

Nozzle types

- **Automatic** - Nozzles that operate independently of other nozzles by means of a detection/activation device built into the nozzle. This activation device is typically a heat responsive element or actuator.
- **Nonautomatic** - Nozzles that do not have individual actuators or heat-responsive elements. These types of nozzles are used in deluge systems where the nozzles are always open.
- **Multifunctional** - Nozzles capable of operation using both automatic and nonautomatic means. The actuation of a multifunctional water mist nozzle can be by a built-in detection and activation device and/or by an independent means of activation.
- **Electronically-operated automatic** - Nozzles that are normally closed and operated by electrical energy that is initiated and supplied by fire detection and control equipment.

Water mist systems

- Water mist systems can be used in many different types of commercial and industrial facilities since they can effectively control the following types of fires:
- **Class A** - Combustible materials (paper, wood, cloth)
- **Class B** - Flammable liquid or gas (grease, gasoline, oil)
- **Class C** - Electrical equipment (appliances, wiring, power tools)

Applications

- Water mist systems are commonly used in areas where traditional fire suppression methods, such as sprinklers, may not be effective or may cause excessive water damage, such as in data centers, museums, and historic buildings.

Water mist systems are frequently used in:
- Machinery spaces
- Industrial oil cookers
- Road and rail tunnels
- Nuclear power plants
- Ship passenger cabins
- Power generation turbines

Benefits of Water Mist Systems

Water mist systems offer several advantages over traditional sprinkler systems and total-flood CO_2 systems.
These benefits include:

Lower water usage – Unlike sprinkler systems, water mist systems require much less water (up to 90% less). This can help reduce the impact on local water sources and reduce water damage in the event of a fire.

Safer for building occupants – Water mist systems do not create hazardous byproducts and are **less likely to cause injury to humans** than other fire suppression methods like CO2 systems.

Lower total cost of ownership – Water mist systems have superior durability, shorter installation times, lower cleanup costs, and require less frequent inspections than other suppression methods.

Greater Versatility – Water mist systems can be used in various applications and settings, from small rooms to large warehouses.

GASEOUS EXTINGUISHING SYSTEMS

- Gaseous extinguishing systems are generally found in areas where equipment is installed that would be highly vulnerable to destruction from water or dry chemical extinguishing agents.
- Computer rooms, electronic gear such as radio receiving and transmitting equipment, and power-generating facilities are examples of areas where gaseous extinguishing system installation would be desirable.
- Carbon dioxide and the halogenated gas systems are most common gaseous systems.

- Gaseous extinguishing systems can be divided into three general categories:
  - Local application;
  - Total flooding; and
  - Hose line systems.

- Local application systems discharge agent onto the burning material and are commonly used for protection of paint dip tanks, restaurant range hoods, and special motors.
- Total flooding systems discharge agent into and fill enclosed space. They are commonly found in flammable liquid storage rooms, computer installations, and transformer vaults containing oil-filled equipment.
- Hose line systems discharge extinguishing agent through manually operated nozzles connected to a fixed supply by piping and/or hoses. At present, carbon dioxide is the only gaseous agent approved for manual hose line systems.

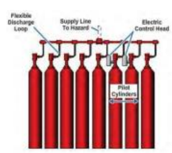
Carbon Dioxide Systems

- There are two general methods of applying carbon dioxide to extinguish a fire.
- One method creates an inert atmosphere in the enclosure or room where the fire is located for a prolonged period of time. This method is called total flooding.
- The second method is to discharge carbon dioxide to the surface of liquids or noncombustible surfaces coated with liquid flammables. This method is known as local application.
- Carbon dioxide is electrically nonconductive.

- It is used extensively for the protection of electrical equipment.
- The non-damaging quality of this agent makes it useful as an extinguishing agent for computer rooms and computer tape vaults.
- There are two general types of carbon dioxide extinguishing systems:
  - High pressure and
  - Low pressure

High Pressure Systems

- In the high-pressure system, high-pressure cylinders are used to store liquid carbon dioxide at ambient temperatures.
- Normal cylinder pressure is nominally 600 psi and varies with the ambient temperature of the storage area.
- Storage area ambient temperatures should not exceed 130°F or be less than 32°F.
- For safety purposes, high-pressure cylinders have a frangible disk that will burst at 3,000 psi to prevent cylinder rupture as a result of over pressurization.



Low Pressure Systems

- Low-pressure systems have a pressure vessel maintained at 0°F by insulation and refrigeration equipment.
- At this temperature, the pressure in the container is approximately 300 psi.
- Because the container is kept at a low temperature, the container can be filled to 90 to 95 percent of capacity.
- For safety purposes, a relief valve is installed to bleed off pressure at 341 psi.
- Another relief valve operates at 357 psi for rapid release of excess pressure.
- There is also a frangible disk designed to burst at 600 psi should the relief valves fail to control pressure buildups.

Advantages/Disadvantages of Low pressure CO_2 Systems

- Low-pressure storage units have a liquid level gauge that continuously monitors the amount of carbon dioxide in storage.
- The smallest low pressure is 750 pounds.
- Low pressure systems do not require hydrostatic testing.
- Low-pressure systems keep the liquid carbon dioxide at 0°F and 300 psi at all times, assuring a uniform discharge rate.
- Another advantage of low-pressure systems is their ability to allow automatic, simultaneous discharge for more than one hazard area on an engineered basis.
- Hose reels can also be attached to these systems to operate simultaneously with hazard protection.

- A reserve supply can be provided by increasing the storage unit size of low pressure systems.
- Usually, low-pressure systems require less floor space for storage of equal amounts of carbon dioxide as compared with high-pressure systems.
- In many instances, low-pressure storage containers may be placed outside the buildings.
- Low pressure systems require one large, single area for the refrigerated storage unit.

Advantages/Disadvantages of High pressure CO_2 Systems

- High-pressure systems require weighing the cylinders.
- High-pressure systems permit storage of almost the exact amount of carbon dioxide required to protect a hazard area because of the flexibility and selection of cylinders in 50-, 75-, or 100-pound sizes.
- High pressure systems require refilling and hydrostatic testing every 12 years.
- Pressures in high-pressure systems vary with the ambient temperature; this affects the discharge rate of the system.
- High-pressure systems require manifolding and valving arrangements to achieve a reserve supply.

- Storage of the carbon dioxide is also a consideration in showing advantages or disadvantages of these systems.
- High-pressure systems require approximately 3 pounds of equipment for every pound.
- High-pressure systems allow flexibility in space requirements because multiple cylinder banks may be stored in several smaller locations.

Operating Devices

- As with all fire protection systems, carbon dioxide systems must have operating devices for discharge of the extinguishing agent and to cause alarms to be actuated.
- Many of the operating devices discussed earlier in this chapter can be used.
- Most commonly used are the heat-actuated devices (HAD) or smoke detecting devices.
- Manual controlling devices are also used in carbon dioxide systems.
- Whether the agent release is automatic or manual, an alarm at the alarm system control unit should be actuated.

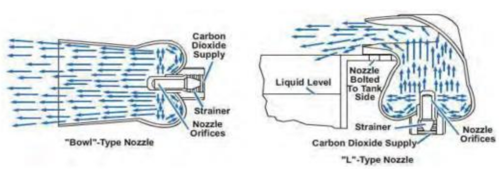
Piping

- Carbon dioxide fire protection system pipe and fittings are selected to have suitable low temperature characteristics and good corrosion resistance inside and out.
- Ferrous metals are galvanized steel, copper, brass, and other materials having similar mechanical and physical properties are acceptable.
- Copper tubing with suitable flared or brazed connections is also acceptable.
- Cast-iron (gray) pipe and fittings are not used.

- Between the storage tank and selector valves, black steel pipe may be used because of the larger sizes involved and its air tightness.
- The supply piping is usually routed to prevent unnecessary exposure to high temperatures from ovens or furnaces or to direct flame impingement before discharge.
- Hot piping causes excessive vaporization of carbon dioxide and a resultant delay in effective discharge.
- Pressure relief devices or valves that prevent entrapment of liquid carbon dioxide may be installed on sections of piping that can be closed off.
- On high-pressure systems, relief devices usually operate at 2,400 to 3,000 psi, and on low pressure systems at 450 psi.

Nozzles

- Nozzles are of various designs and discharge patterns.
- Two common types are shown



Total Flooding Systems

- Total flooding systems are used for rooms, ovens, enclosed machines, and other enclosed spaces containing materials extinguishable by carbon dioxide.
- To be effective, the space must be reasonably well enclosed so that the gas can displace the oxygen in the room.
- There are detectors that activate the system and automatic closing devices that close windows, doors, vents, etc., and set off alarms before the system discharges.

Local Application Systems

- Local application systems are used to protect hazards, such as oil-filled transformers and paint dip tanks.
- Ventilating fans, conveyors, flammable liquid pumps, and mixers associated with the operation may be interlocked to shut down automatically when the protection system is activated.