Introduction to Fire Fighting Systems

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Fire Sprinkler Systems

What is a Sprinkler System

- A *fire sprinkler system* is an **ACTIVE** fire protection measure, consisting of a water supply system, providing adequate pressure and flow of water through a distribution piping system, onto which fire sprinklers are connected,

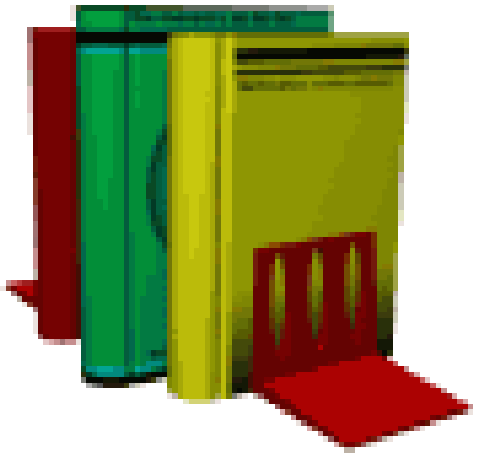
- Sprinkler systems have been around since the late 1880's,

- In 1874, H.S. Pamelee patented the first practical automatic sprinkler,

Life Safety Considerations

- No reported multiple deaths in a completely sprinkled building,
- Life Safety is enhanced,
- Combustion products are limited, with extinguishment in the incipient stage,
- Controls 70% of all fires with five or fewer sprinklers activated.

The Codes



The Codes

- By code definition, there are TWO categories of fire suppression systems;
  - Required Systems
  - Non-Required Systems

- *Required Systems* are those required to be installed, by code, due to life safety and/or building contents,

- *Non-Required Systems* are installed systems not required by the code,

The Codes

- It is unlawful to occupy any portion of a building until the *REQUIRED* suppression system has been tested and approved,

- When a *REQUIRED* system is out of service, and where required by code enforcement, the building shall evacuated or an approved Fire Watch shall be provided, whose only duty is to patrol the premises and keep watch for fires,

- The Fire Watch must have means to notify the FD.

Sprinkler Design

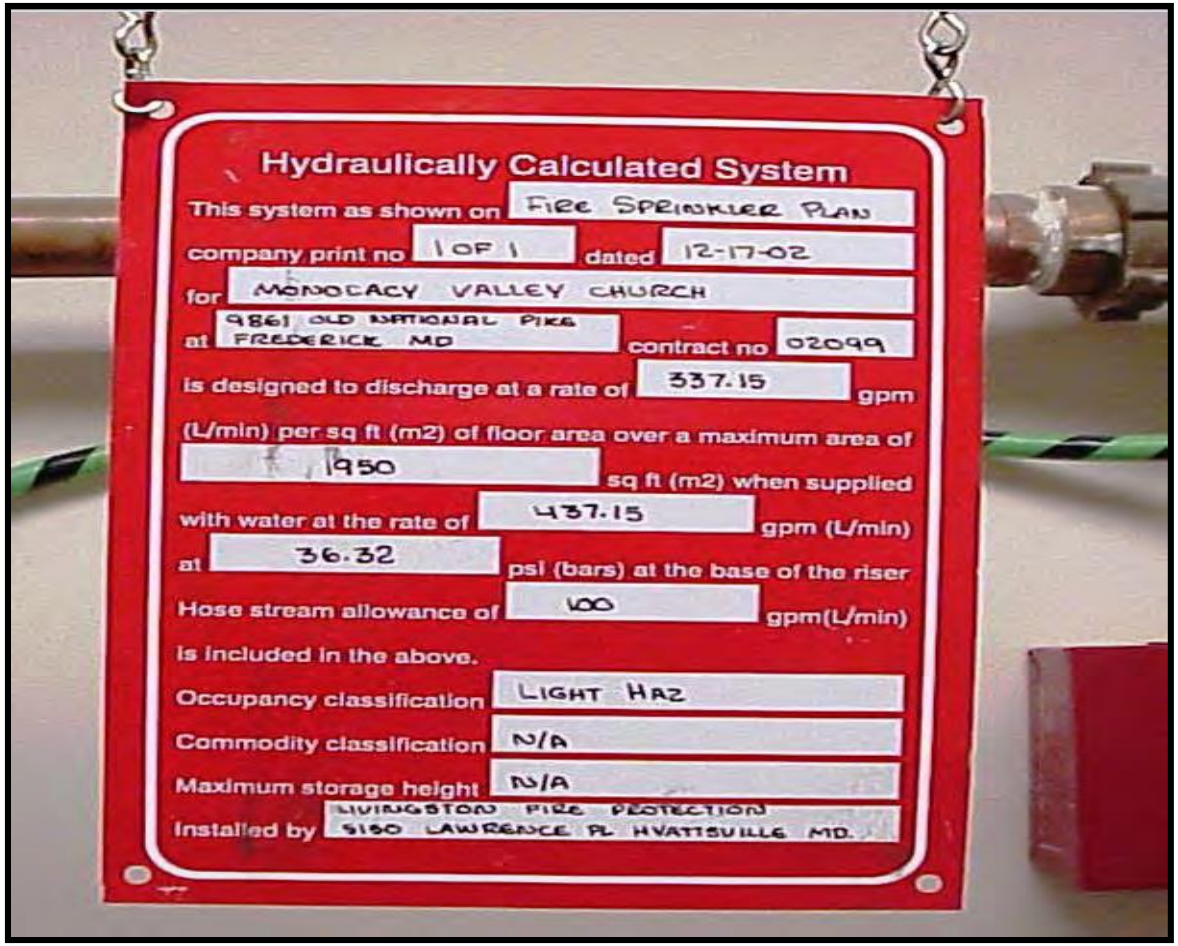
Design

- There are *two* ways to design a sprinkler system;

  Pipe Schedule or Hydraulically Calculated.

- **Pipe Schedule**:
  - pipe is sized according to systems pressure and required flow,
  - sprinkler discharge density and estimated area of coverage determine pipe size,

- **Hydraulic Calculated**:
  - an engineered approach to match fire hazard to potential water supply pressure and volume,
  - most automatic sprinklers today are hydraulically calculated,



- NFPA 13 requires hydraulically designed systems to have a secured sign placed at the valve supplying designed area. This in addition to the "General Information" sign,

Design

- NFPA Standard 13, *"Standard for the Installation of Sprinkler Systems"*, now requires, on new systems, a permanent marked and secured *"General Information Sign"*,

- While sign is helpful, it should not be considered a complete hazard assessment of the building or system.

GENERAL INFORMATION SIGN

NAME: Sweetwater River Logistics Systems
ADDRESS: 10701 Silcantu Parkway, Suites 100-500
HIGH PILED STORAGE PRESENT: Yes X; Double Row Rack
MAXIMUM HEIGHT OF STORAGE PLANNED: 28-0
AISLE WIDTH PLANNED: 8-0
COMMODITY CLASSIFICATION: High Hazard
ENCAPSULATION: No
PRESENCE OF SOLID SHELVES: No
FLOW TEST: Q = 2,100 GPM Static P: 90 PSI Residual P: 82 PSI
PRESENCE OF FLAMMABLE/COMBUSTIBLE LIQUIDS: No
PRESENCE OF HAZARDOUS MATERIALS: Yes, Level 3 Aerosols
PRESENCE OF OTHER SPECIAL STORAGE: Yes, idle wood pallets
AUXILIARY/LOW POINT DRAIN LOCATIONS: None exist
ORIGINAL MAIN DRAIN TEST: Static P: 80 PSI Residual P: 70 PSI
REQUIRED SPRINKLER CLEARANCE: 36 inches
ANTIFREEZE SYSTEM OR AUXILIARY VALVES: No
INSTALLING CONTRACTOR: Lamar Fire Protection, Kyle TX

Sample of "General Information Sign" required by NFPA 13 on new systems

Types of Systems

Sprinkler Installation Type		Installed where
1	Wet Pipe System	Occupancies with temperature 95°C > X > 0°C
2	Dry Pipe System	Occupancies with risks of temperature X < 0° and X > 95° C
3	Deluge Systems	Occupancies with rapid fire spread
4	Preaction Pipe Systems	In occupancies where water damage is not accepted by accidental activation

Types of Systems

There are ***four*** ***major*** types of sprinkler systems;

- The **Wet Pipe** system,
- The **Dry Pipe** system,
- The **Deluge** system and
- The **Pre-Action** system.

Types of Systems

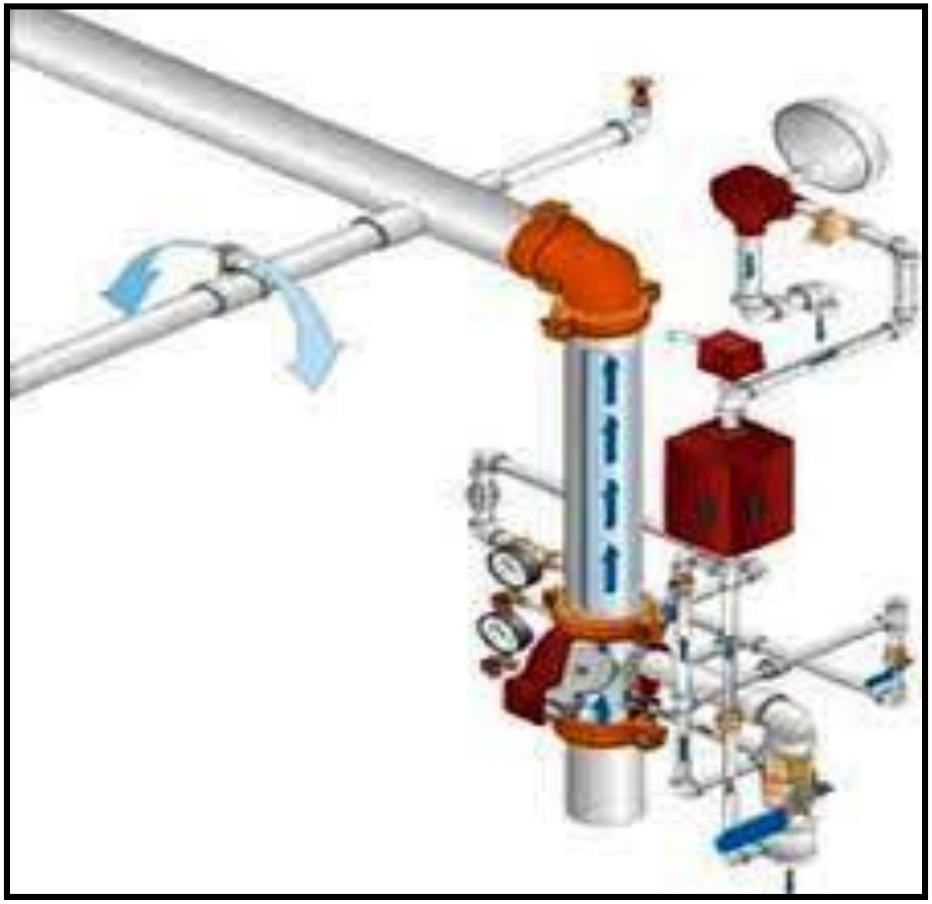
Wet pipe --------- *by far the most common,*

Dry-pipe --------- *where water freezing is possible,*

Deluge ---------- *for high hazard applications,*

Pre-Action ------- *where concerns over water damage.*

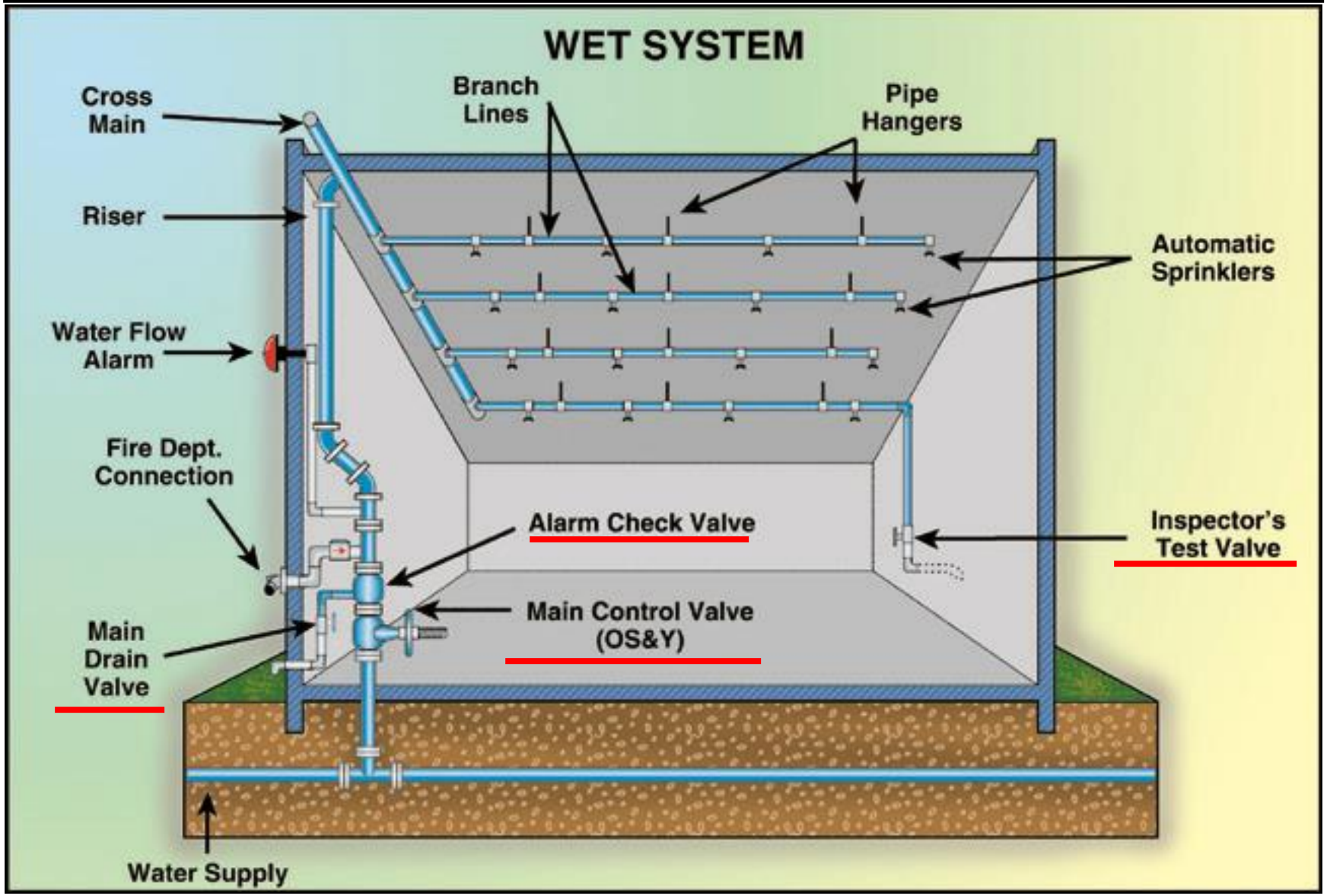
Wet Pipe Sprinkler



Wet Pipe Sprinkler

- Pipes are always filled with water. Heat from fire opens a sprinkler head,
- Usually only one or two heads open,
- Water flows until it is shut off,
- The open sprinkler head(s) is replaced and the system is reset.

An opening sprinkler head triggers the system



Wet Pipe Sprinkler

- A one-way clapper prevents water from re-entering the water supply,

- Gauges on both sides of the main valve, register pressure on the supply and system sides,

- A retard chamber prevents sudden pressure surges which could cause a false alarm,

- An *alarm check valve* detects water flow and activates the alarm system,

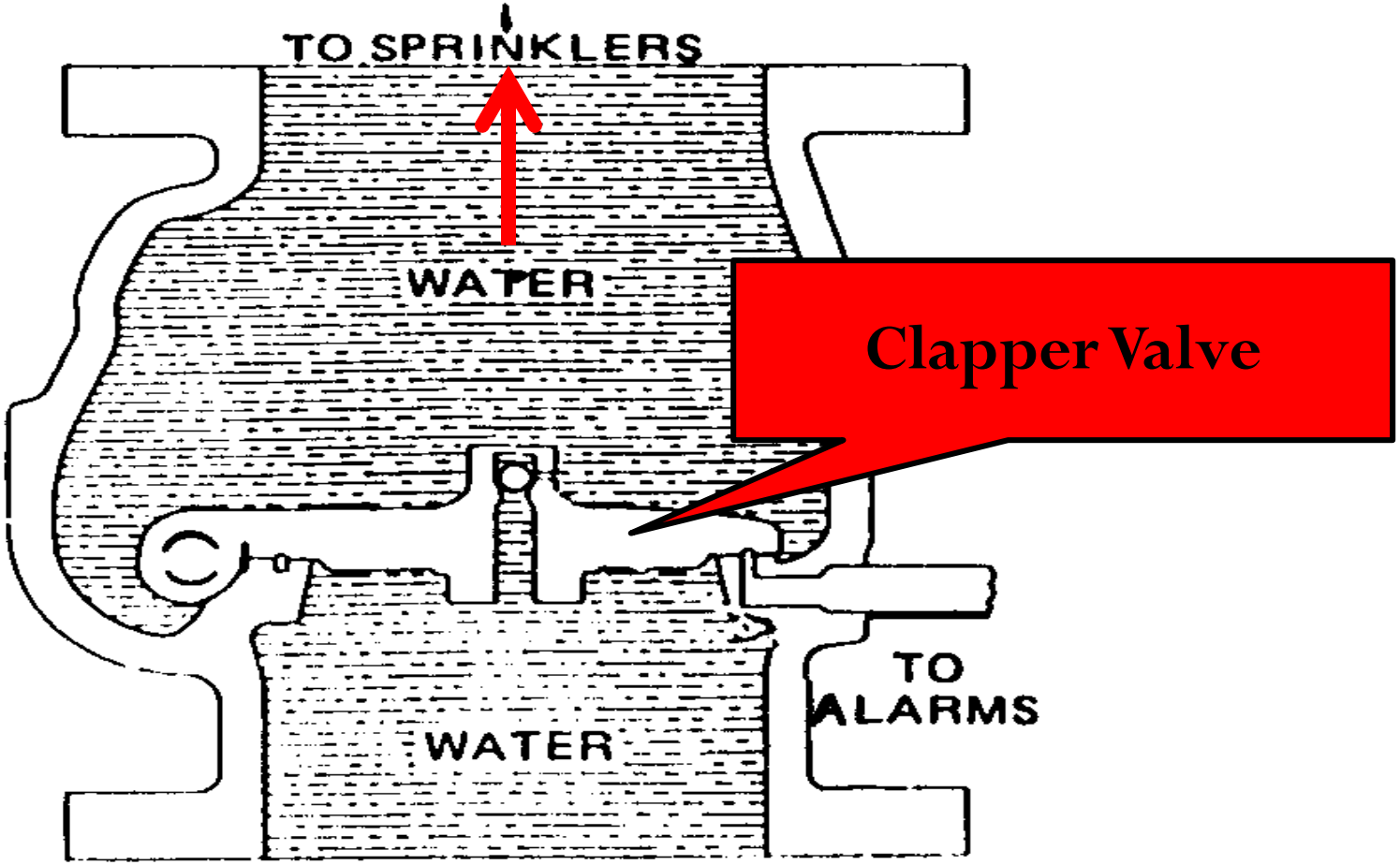
Wet Pipe Sprinkler

- There is a control valve to shut off the system, normally an *O.S.&Y.* (Outside Stem and Yoke) or (Outside Screw and Yoke),

- There is a *main drain valve* which drains the system for service,

- And an *Inspectors Test Valve*, usually at the end of the system, used to simulate flow from a single head and to measure the system response,

Typical wet pipe sprinkler valve



Wet Pipe Sprinkler

- ***Restoration of the System, Liability Issues;***

  - Some occupancies have **<u>required</u>** systems for life safety, i.e., public assembly, hotels and high-rises,

  - Does your FD allow restoration of the system?

  - If Not, then require a FIRE WATCH or EVACUATE THE BUILDING…..

  - Or at least, shut off the closest control valve and leave the rest of the system operational,

Wet Pipe Sprinkler

- If your SOP allows restoration;
  - after the fire is completely under control, the closest sectional water control valve should be closed,
  - the main control valve should not be closed unless there are no sectional valves,

Wet Pipe Sprinkler

- ***Restoration of the System;***

  - shut down any water source supplying the system,

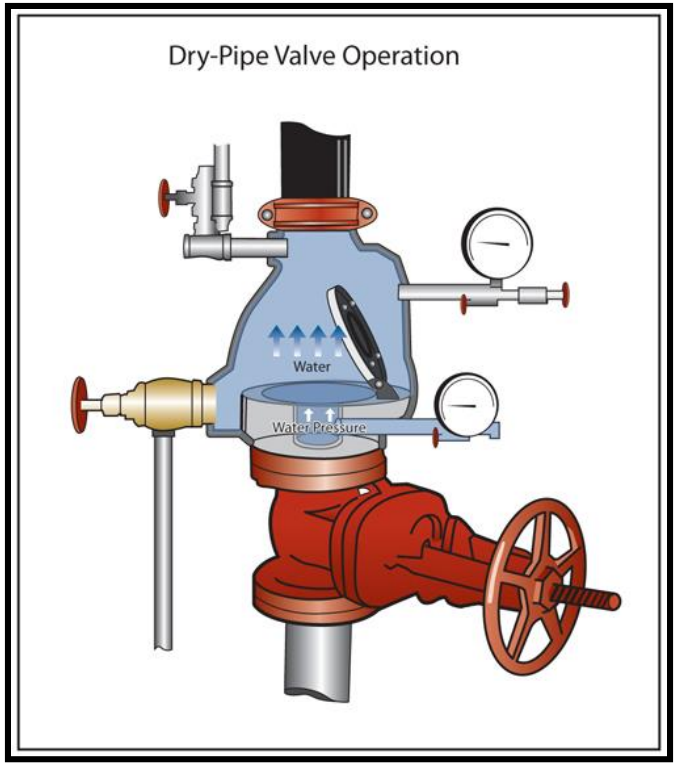
  - the sprinkler head(s) are replaced with an identical one from the spares in the sprinkler control room,

  - re-open any closed control valves,

  - open the Inspectors Test Valve to ensure water is flowing to the topmost sprinkler.

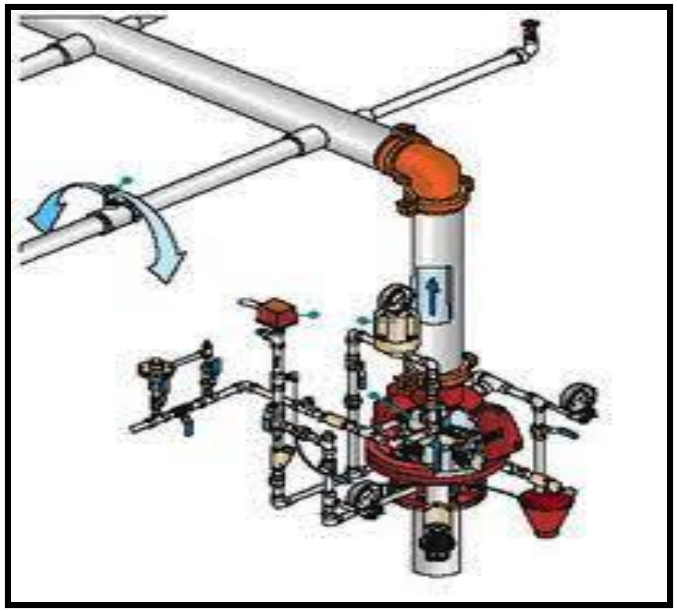
Wet Pipe Sprinkler System

Dry Pipe Sprinkler



Dry Pipe Sprinkler

- Dry pipes systems are used in unheated buildings, but the valve room <u>must</u> be heated,



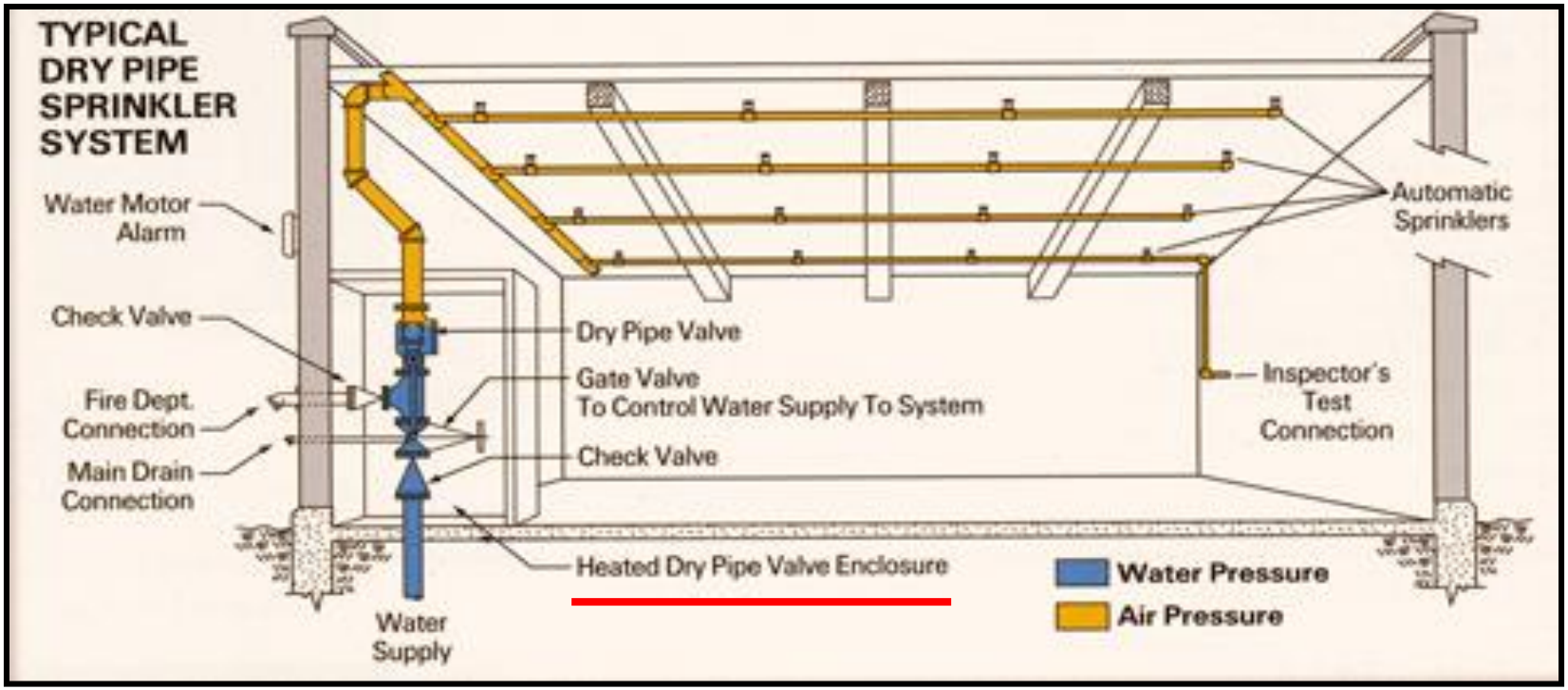
- Dry pipe systems are more difficult to design than wet pipe systems and are harder to restore,

Dry Pipe Sprinkler

- Pipes are not filled with water (but with pressurized gas or air),
- Heat from a fire opens a sprinkler head,
- Usually only one or two heads open,
- Air pressure drops in the piping and opens a water valve (the dry-pipe valve),

Dry Pipe Sprinkler

- Water fills the pipes and exits through an open sprinkler head(s),
- Water flows until shut off,
- Open sprinkler head is replaced,
- System is reset,



- Pipes in protected space are filled with air or inert gas; an opening sprinkler head, triggers the system by releasing the air or gas, which allows water to flow into the pipes and then out through the open sprinkler head,

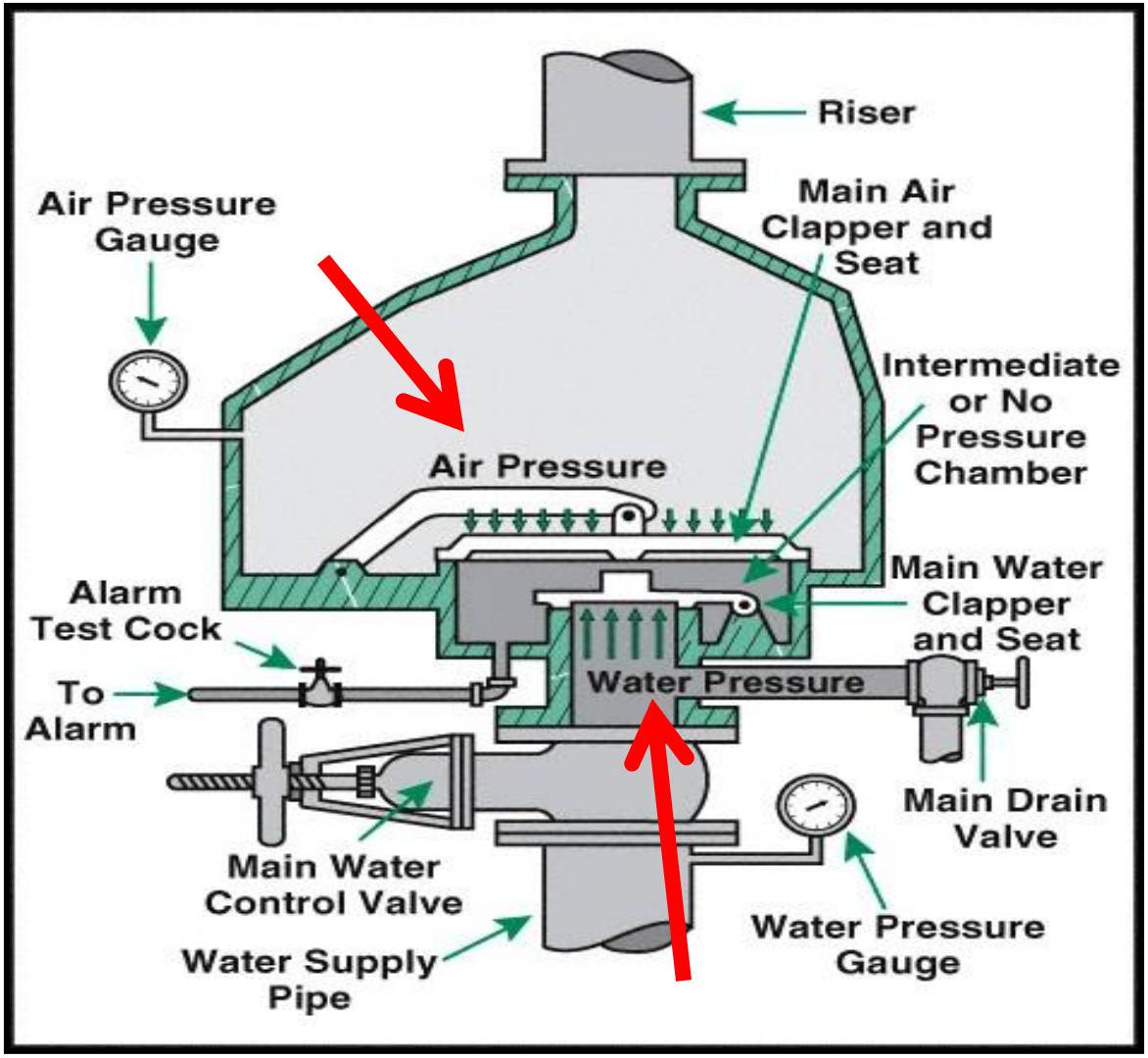
Dry Pipe Sprinkler

- A *dry pipe valve* keeps pressurized air above the supply water pressure,

- The *clapper valve* has a locking mechanism to keep the clapper open until it is reset, by draining the system, opening the dry pipe valve cover and resetting the lock,

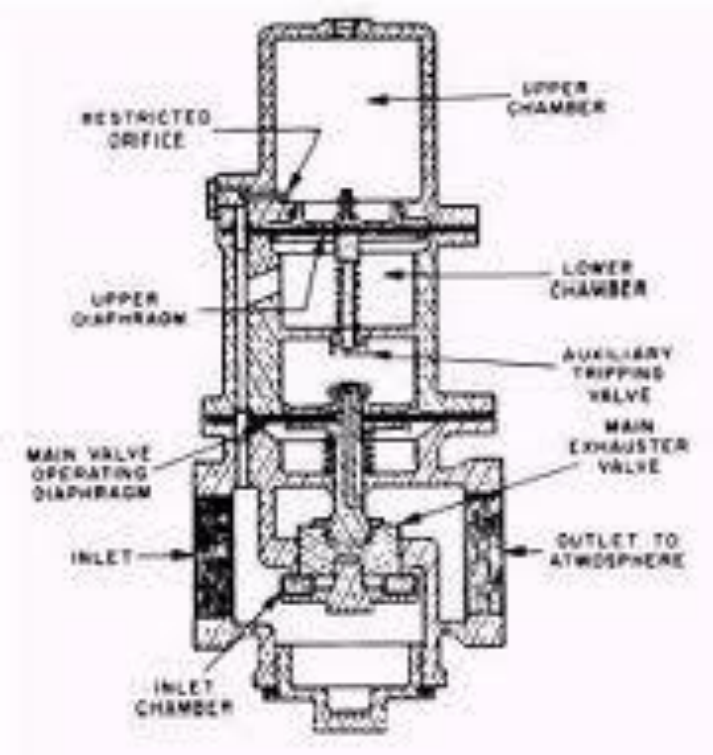
- Dry pipe systems are a little slower to activate than wet pipe systems, so most have either an *Exhauster* or *Accelerator* to speed up the system operation,

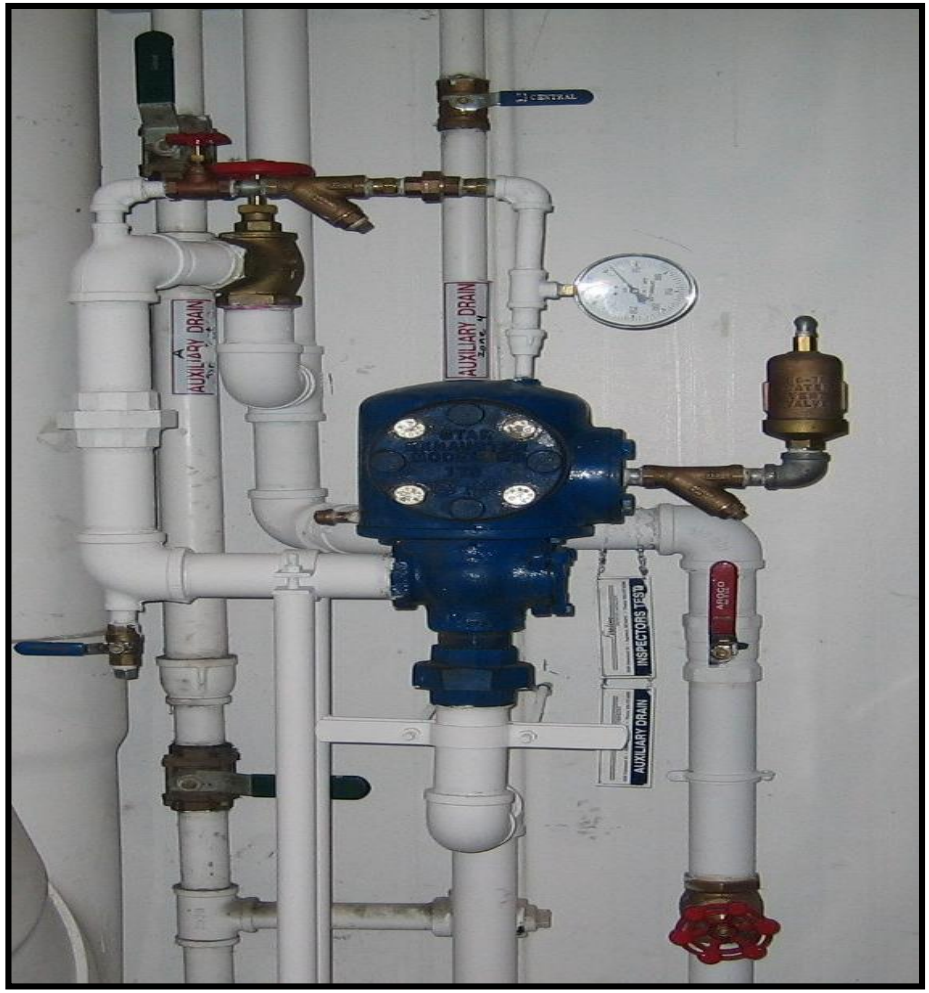
Typical Dry Pipe Valve



Dry Pipe Sprinkler

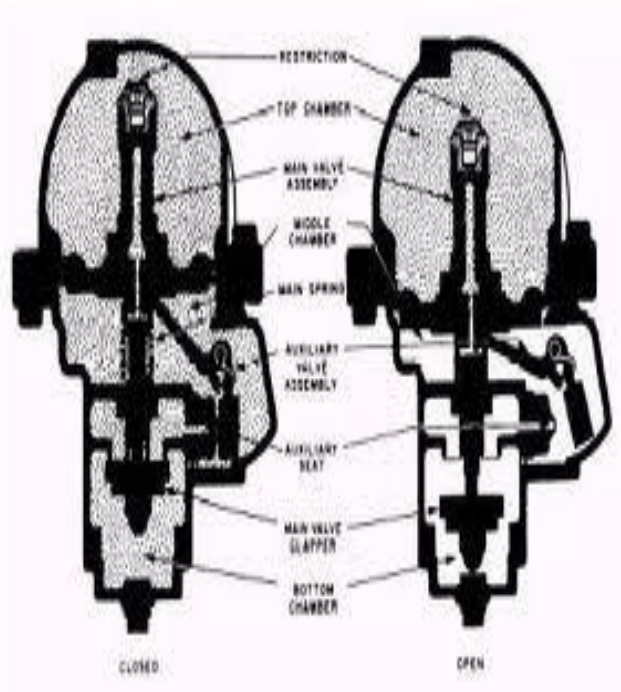
- The ***Exhauster*** detects decrease in air pressure and helps bleed off air,





Dry Pipe Sprinkler

- The ***<u>Accelerator</u>*** detects decrease in air pressure and pipes air pressure below the clapper valve, to speed up it's opening,

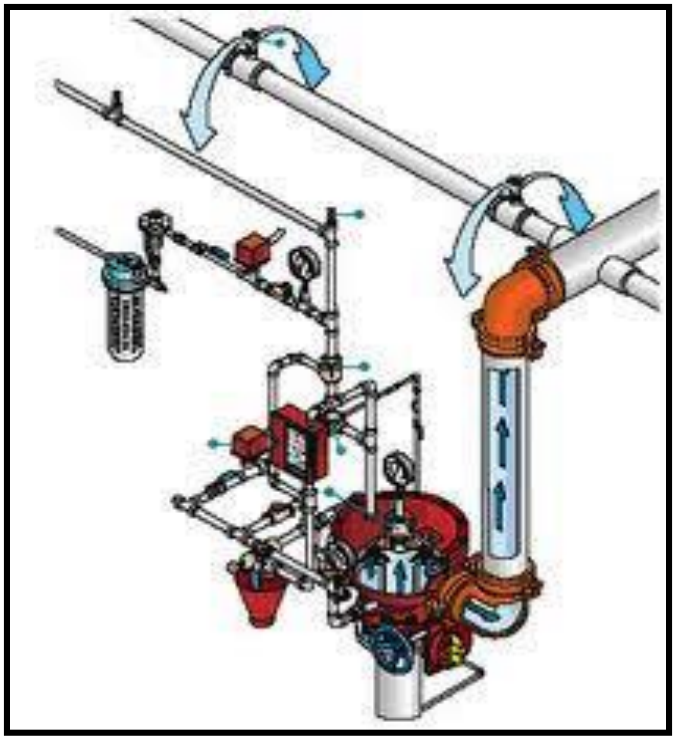


Typical Dry Pipe Sprinkler set up

Dry Pipe Sprinkler

- ***Restoration of the System;***
  - resetting is <u>not</u> usually performed by FD personnel,
  - notify the property owners that the system has activated,
  - the system has to be drained and the dry pipe valve has to be reset, this is a complex procedure,

Deluge System



Deluge Sprinkler

- Pipes are not filled with water (or gas),
- All sprinkler heads are pre-opened,
- A signal from a detection device mechanically opens a water valve,
  - water fills the pipes and flows from all heads,
  - water flows until shut off,
  - system is reset.

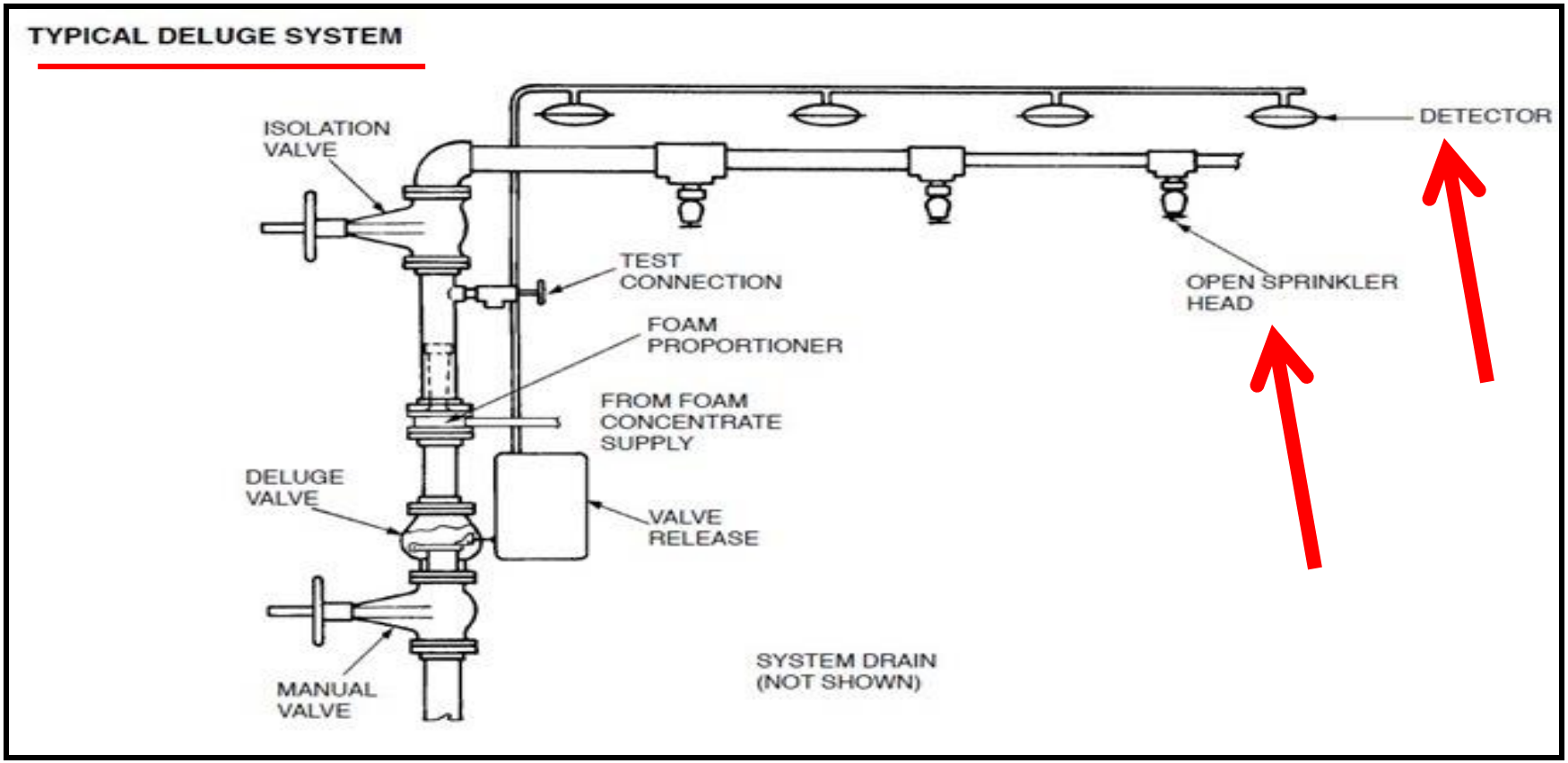
Deluge Sprinkler

- Primarily installed in special hazard areas that have fast spreading fire, (i.e. petroleum facilities, hazardous materials),

- Are also used to apply AFFF foam.

- Activation will cause great quantities of water or foam to flow

- Usually requires several detectors to activate before discharging.



- Pipes in protected area are empty; a detector signal triggers the system, allowing water/foam to enter pipes and flow from all sprinkler heads (which are already open),

Deluge System

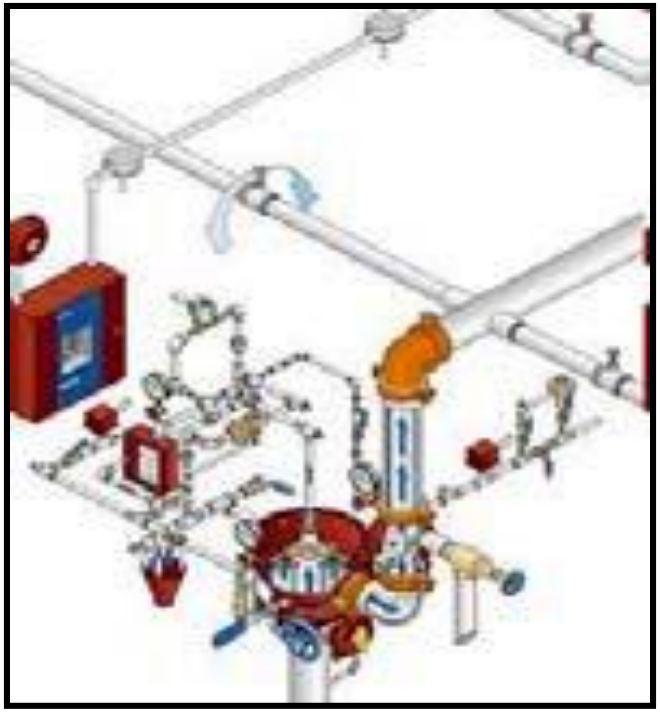
- ***Restoration of the System;***

  - the deluge clapper valve must be manually reset with the latching mechanism in place,

  - the detection system is re-activated,

  - because of these procedures, it is <u>not</u> recommended for the FD to restore the system, leave it to the professionals.

Pre-Action System



Pre-Action Sprinkler

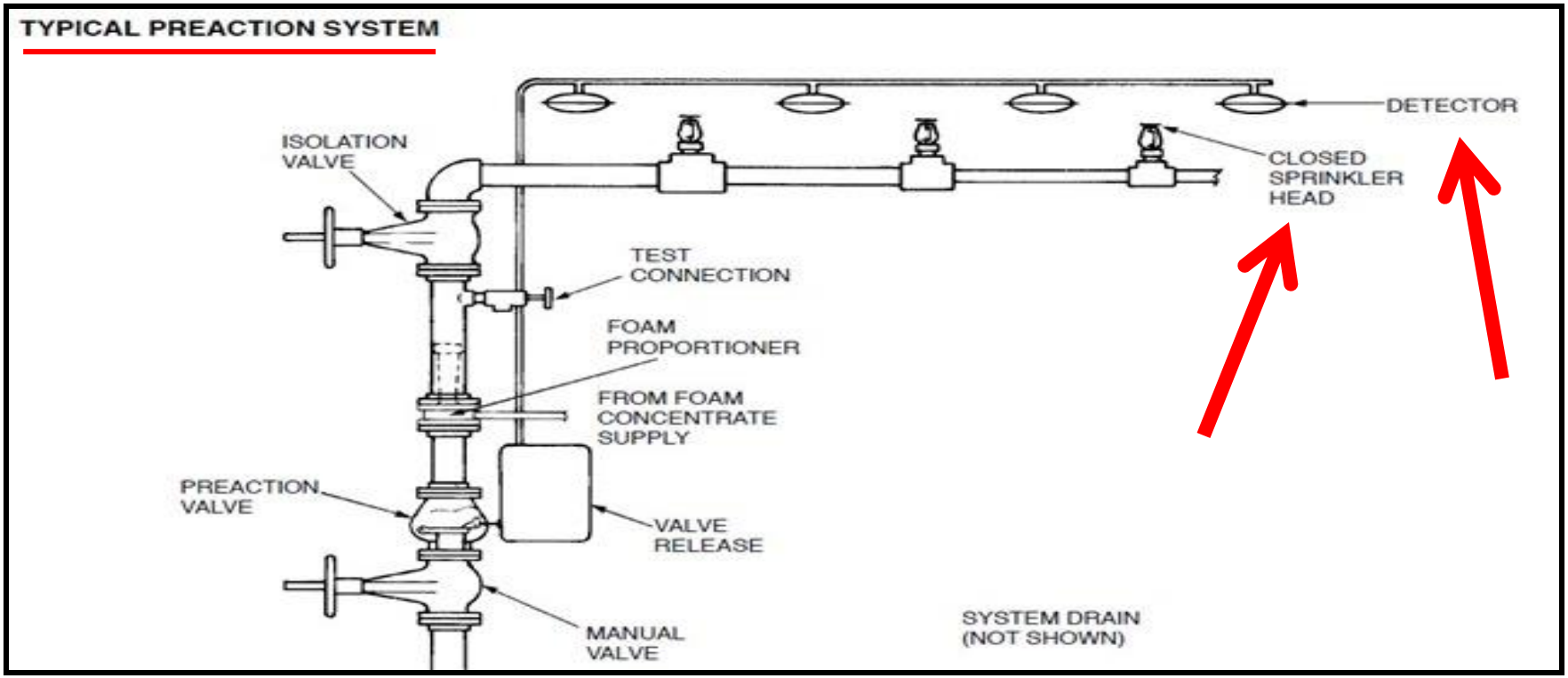
- ❑ Pipes are not filled with water,
- ❑ All sprinkler heads are of the standard type (they are closed),
- ❑ A detection device opens a water valve,
- ❑ Water fills the pipes,
- ❑ Water only flows from a sprinkler head *if it is opened* by heat from a fire,
- ❑ Water flows until shut off and system is reset.

Pre-Action Sprinkler

- Used primarily to protect property where water could severely damage facilities or equipment, (historical items)

- Similar to dry-pipe and deluge system;
  - closed piping,
  - little or no air/gas pressure,
  - water does not flow to the sprinkler heads until detector activates,
  - water on fire after sprinkler head fuses,

- Turns into a wet system, but allows personnel to check/fight fire before head fuses,



- Pipes in protected area are empty; a detector signal triggers the system, allowing water to enter pipes and flow into piping network; heat from a fire may then open a sprinkler head; accidental damage to a head will not result in water flow,

Pre-Action Sprinkler

- ***Restoration of the System;***

  - the deluge clapper valve must be manually reset with the latching mechanism in place,

  - the detection system, with supervisory features is re-activated,

  - because of these procedures, it is <u>not</u> recommended for the FD to restore the system, leave it to the professionals.

Sprinkler Heads

Sprinkler Heads

- Sprinkler heads are the key components of the system,
  - Heads must be suitable in design, performance, application and temperature for type of property it is protecting,
  - Standard heads are marked with ***SSU*** (standard sprinkler upright) or ***SSP*** (standard sprinkler pendent) on the deflector,
  - Side wall heads may be pendent, upright, or horizontal,

frangible bulb

Sprinkler Heads

fusible link

- The typical sprinkler head is activated by heat (temperature),
  - opens when a triggering action occurs,
  - a frangible bulb breaks (color indicates temperature setting),
  - a fusible link melts,
  - water flows when head is opened,
  - water is manually shut off,
  - once activated, head must be replace,

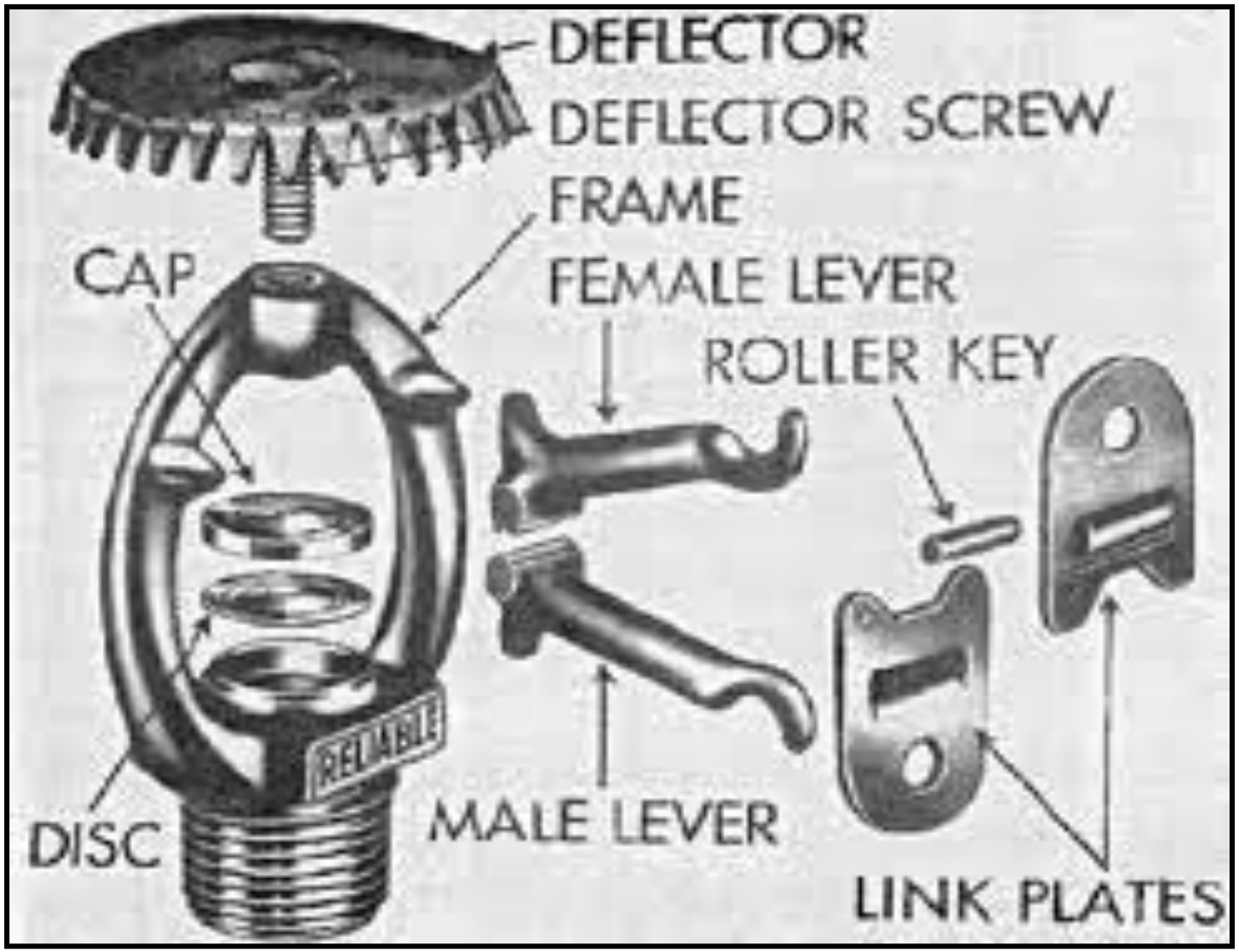
Sprinkler Heads

- *Types*;
  - Upright
  - Pendant
  - Sidewall
  - Recessed heads

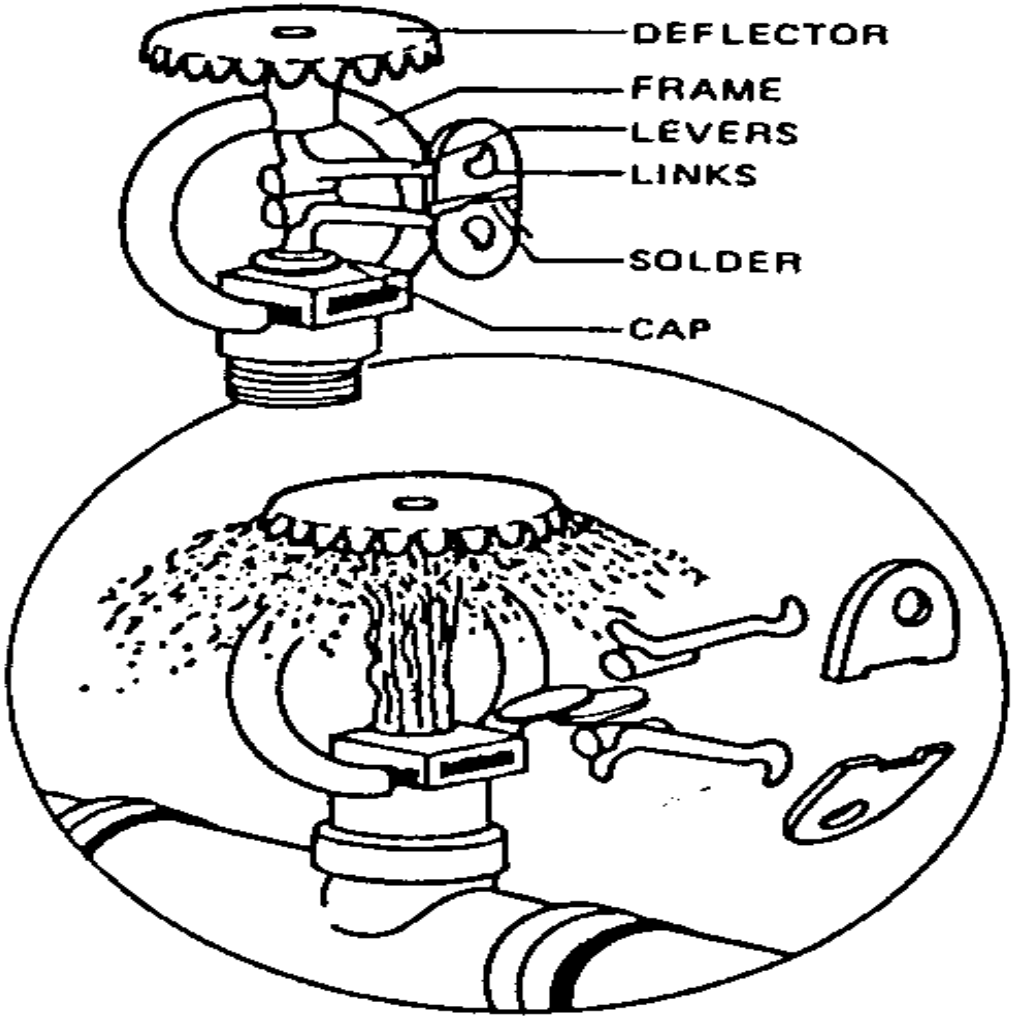
Sprinkler Head Temperature Ratings, Classifications and Color Coding

Temperature Rating		Temperature Classification	Color Coding	Glass Bulb Colors
F	C			
135-170	57-77	Ordinary	Uncolored or Black	Orange or Red
175-225	79-107	Intermediate	White	Yellow or Green
250-300	121-149	High	Blue	Blue
325-375	163-191	Extra High	Red	Purple
400-475	204-246	Very Extra High	Green	Black
500-575	250-302	Ultra High	Orange	Black
625	343	Ultra High	Orange	Black

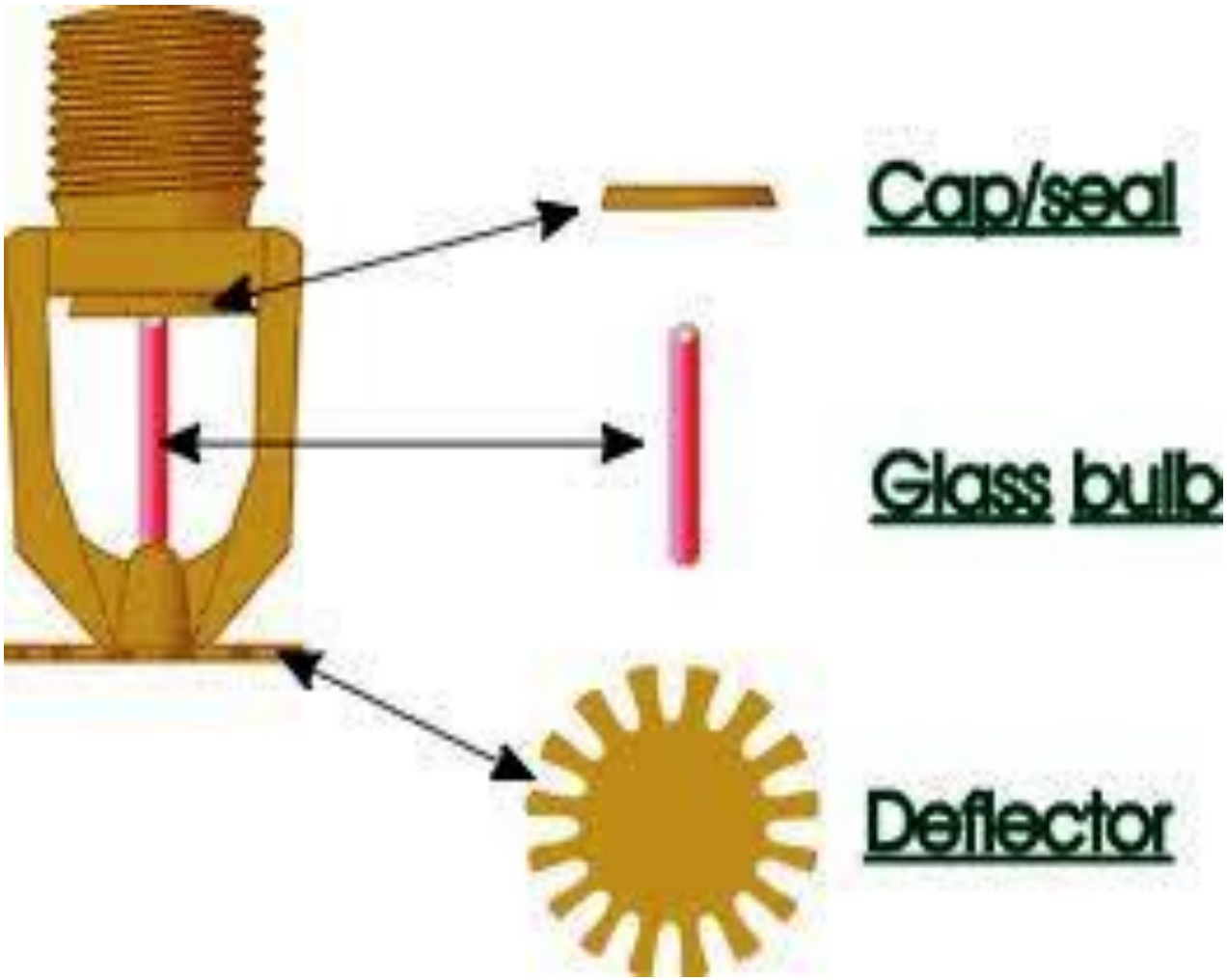
Sprinkler Head Parts



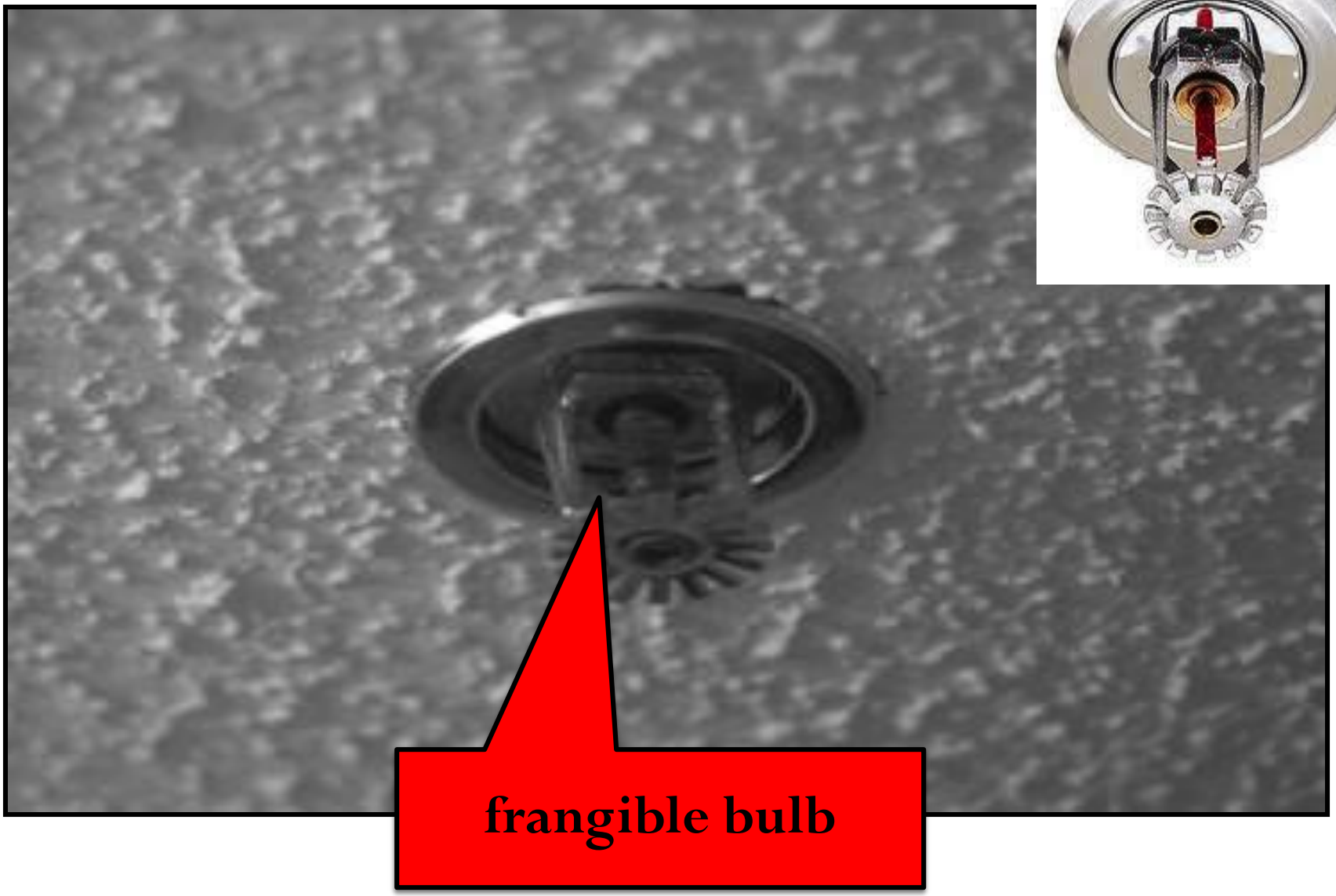
Fused Sprinkler Head



Frangible Bulb Head

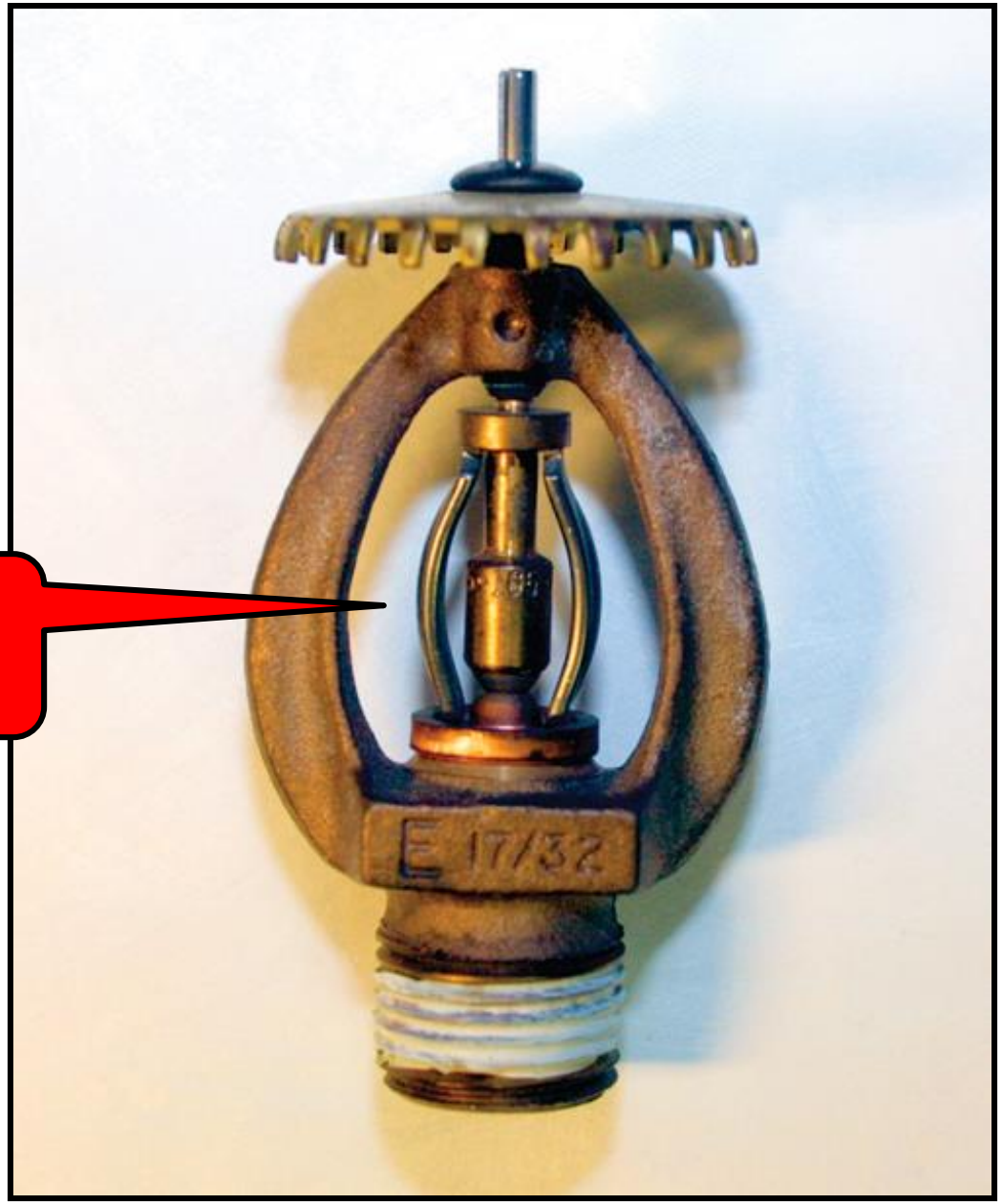


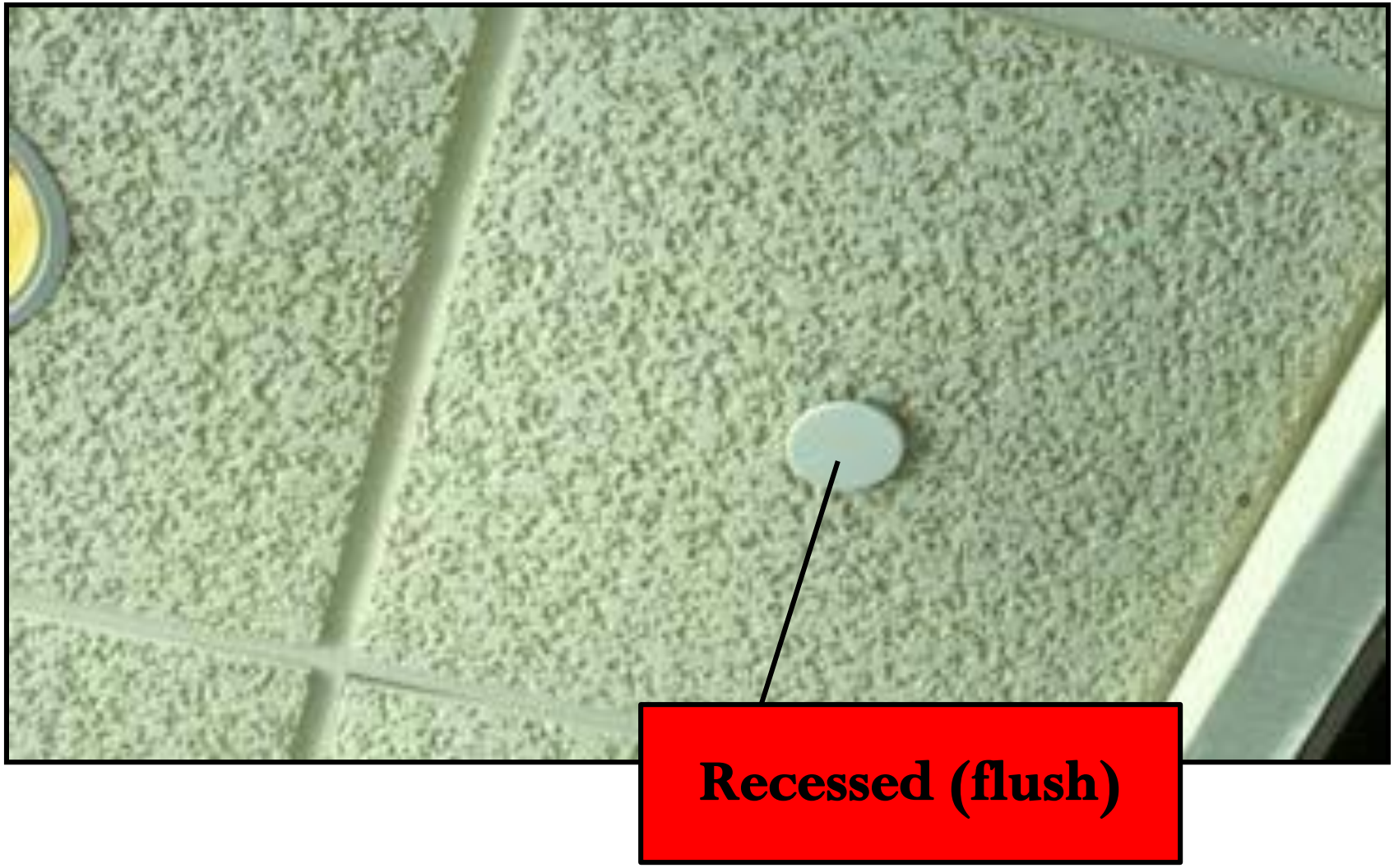

Conventional
Upright
Pendent
Horizontal Sidewall
Vertical Sidewall
Recessed Pendent
Recessed Pendent
Concealed Horizontal Sidewall
Concealed Pendent


frangible bulb


fusible link

Chemical pellet




Recessed (flush)

Sprinkler Heads

- **Storage Cabinet;**
  - extra heads
  - sprinkler wrench

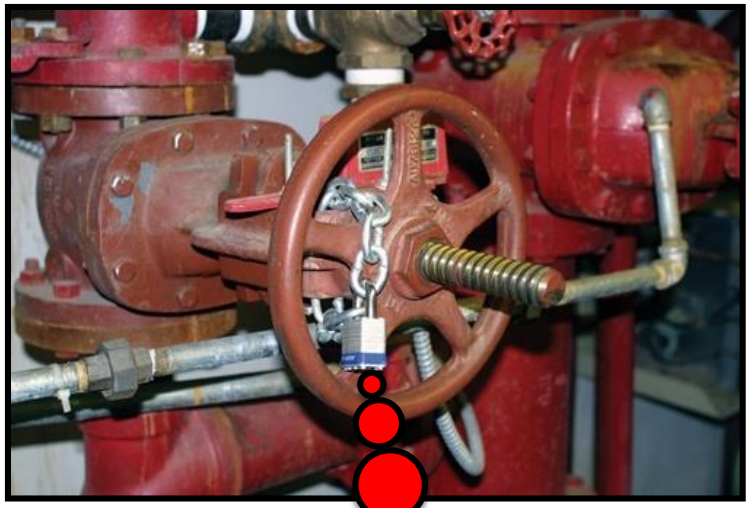
- Cabinets hold a minimum of six sprinklers and sprinkler wrench in accordance with NFPA® 13.

  - Less than 300 heads min 6 spares
  - 300 – 1,000 heads min 12 spares
  - More than 1000 heads min 24 spares

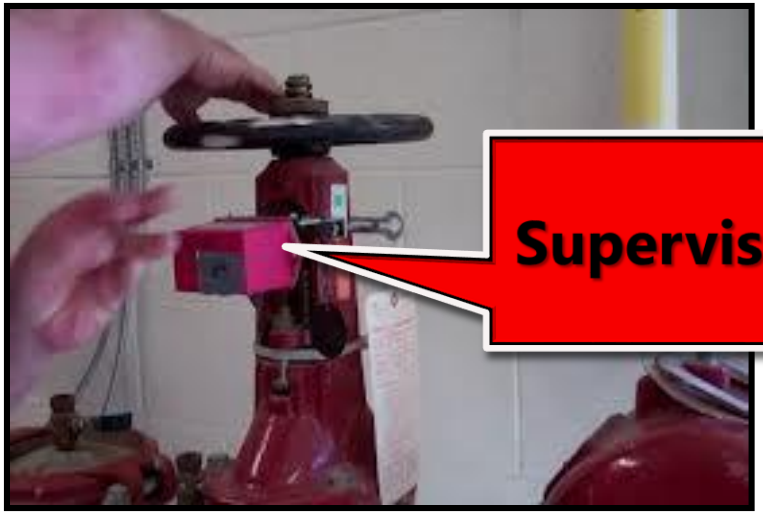
Control Valves

Control Valves

- OS&Y Valve
- Post Indicator Valve (PIV)
- Post Indicator Valve Assembly (PIVA)
- Operating Valves

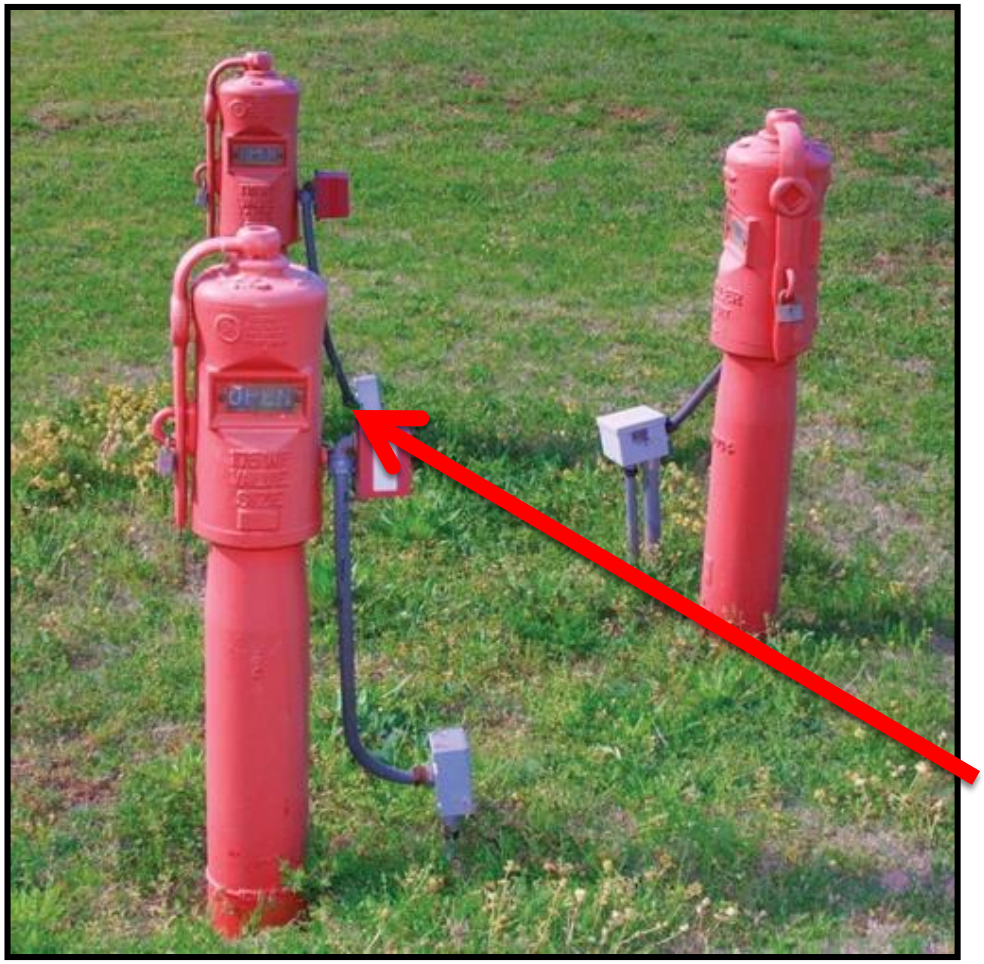


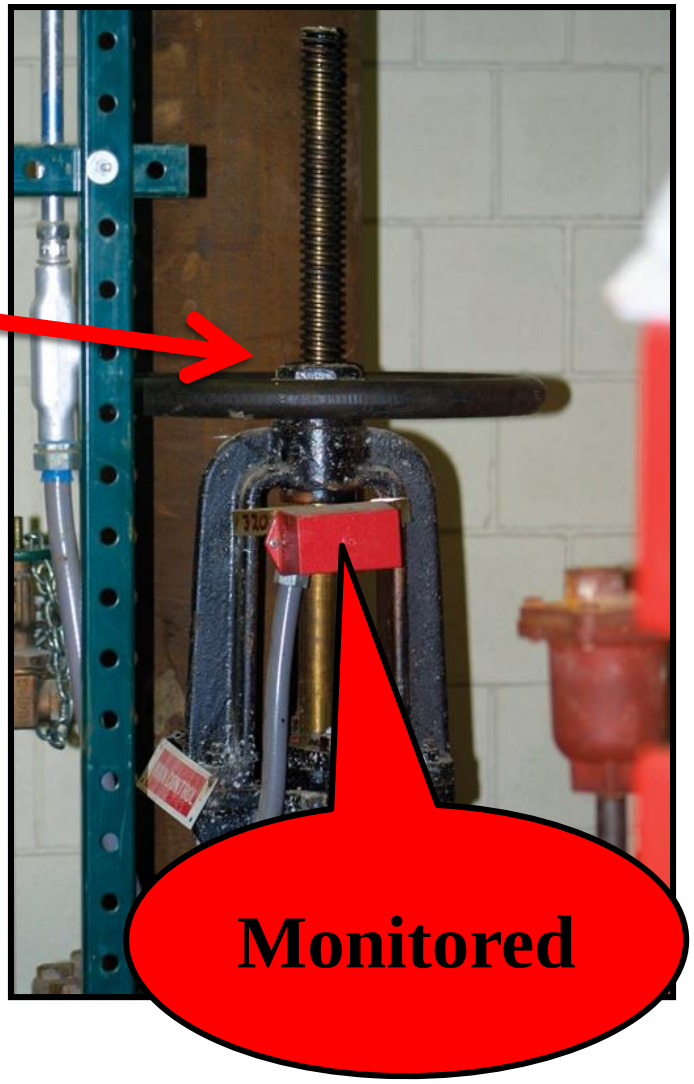
OS&Y secured in open position by chain & lock



Supervised control

- Outside Screw and Yoke (OS&Y) Valve





- Post Indicator Valve (PIV)

- Wall Post Indicator Valve (WPIV)

- Post Indicator Valve Assembly (PIVA)

Waterflow Alarms

- Hydraulic or Electrical;
  - warn of water movement in system,
  - hydraulic alarm sounds local,
  - electrical alarm sounds local and fire alarm system.

Fire Department Connection

Fire Department Connection (FDC)

- Connection usually by-passes control valve;
  - system can be used regardless of position control valve is in.

- Location:
  - should be one located near main entrance of building,
  - others may be located at various locations around building,
  - for use by additional companies,
  - when system is divided into zones.

Fire Department Connection (FDC)

- allows FD to pump *supplemental* water,
- shall be visible and recognizable,
- located and arranged so that hose lines can be attached without interference,
- min size of fittings 2 ½" (65 mm) *(FCNYS)*,
- have a sign with at least 1" letters that read "AUTO SPRINKLER",
- shall not be less than 18" or more than 48" above grade.

What it looks like

NFPA Standards and NYS Codes do not specify color coding of systems. (NYC regulation)

Fire Department Connection (FDC)

- Safety consideration:
  - Do not put your hands in the FDC to clear debris out, because it may have the presence of:
    - broken glass,
    - sharp metal,
    - used drug needles,
    - even a bee's nest

Fire Department Connection (FDC)

- Difficulties may be encountered with the FDC;
  - These difficulties may include:
    - missing or tight caps,
    - defective or incompatible threads,
    - debris stuffed into the connection,
    - female swivels out-of-round,
    - frozen female swivels,
    - and clappers either broken or jammed open,

Fire Department Connection (FDC)

Cans, bottles, balls, metals and drug needles have been shoved into FDC's. <u>Don't use your hands to clean it out!!!!</u>

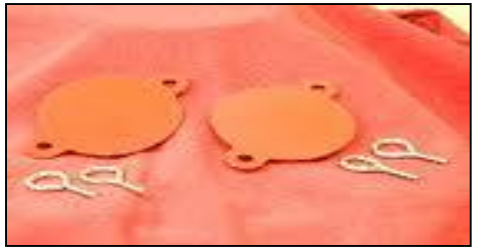
If the FDC is not usable, notify the IC that water can not be supplied to the system.

Fire Department Connection (FDC)

- Some Remedies; *(frozen swivels, defective clapper)*

  - a spare male cap should be carried in the event it becomes necessary to cap one side of the FDC to prevent an outflow of water due to a malfunctioning clapper valve,
  - connecting a second line is another solution,
  - tap the swivels with a spanner wrench to loosen paint, dirt, etc.,
  - twist the supply hose 4 to 5 left turns, insert and turn to the right,

Fire Department Connection (FDC)



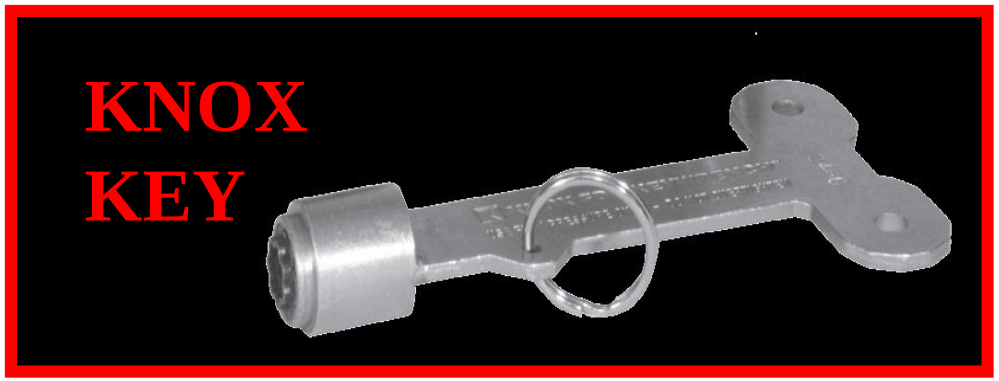
- Many FDC's are equipped with either metallic or plastic vandal proof caps,

  - these caps are usually attached with screw eyes placed over the pin lugs on the female swivel,
  - both metal and plastic caps are removed by striking the center of the cap with a tool,
  - caps can also be removed by prying one of the screw eyes off the pin lug.

Fire Department Connection (FDC)

Some FD's use security caps, responding mutual aid departments, *without the key*, will not be able to remove the cap……..

Knox registered FD 's should request extra keys for their mutual aid departments,



Sprinkler System Failures

Sprinkler System Failures

- There are ***three*** principal causes of unsatisfactory sprinkler performance;

    1. A closed valve in the water supply,
    2. Inadequate water supply delivery,
    3. Occupancy changes negating the system design.

- Pre-planning, inspections, proper maintenance and testing should correct these problems.

Sprinkler System Failures

- One of the leading causes of sprinkler system ineffectiveness occurs when storage contents or configurations change and the system is not altered to match the new hazard,

- Original sprinkler spacing, pipe size or water delivery capacity might not control the new storage or layout,

FD Operations

FD Operations

- We connect to the FDC in case of insufficient water supply or many heads opened taxing the system,

- Upon arrival, stretch a supply line to the FDC, but don't charge it until confirmed working fire,

- Whenever possible, augment the system with two different pumpers,

- Charge the line, <u>start</u> pump pressure at 150 psi unless system is posted for a different pressure,

FD Operations

- If hose lines are used for firefighting, water for the system should be taken from sources that do not reduce sprinkler protection,

- Verify water is flowing from the system, if not, check if control valves are open, have a FF with a radio positioned at the valve,

- If present, shut the system down by using a sectional or floor control valves instead of the main control valve,

FD Operations

- If system is connected to a potable water supply, avoid drafting from open water sources unless backflow protection is installed,

- Unless tagged *"Closed for Repair"*, any control valves not open, should be reported to the fire investigators office,

Summary

- Never shut the system down to improve visibility,
- Don't shut the system down until fire has been extinguished,
- Notify the IC if water can not be supplied to the system due to defective FDC,
- Lastly, a properly designed, installed, maintained and FD augmented system can supply water directly to the fire in a more effective manner than manual fire suppression,

Thank You

Questions?

NFPA 13: Installation of Sprinkler Systems

- Establishes the requirements for the layout and design of sprinkler systems

Maximum Coverage for a Sprinkler System

- Light Hazard: 52,000 square feet
- Ordinary Hazard: 52,000 square feet
- Extra Hazard (Pipe Schedule): 25,000 square feet
- Extra Hazard (Hydraulically Calculated): 40,000 square feet

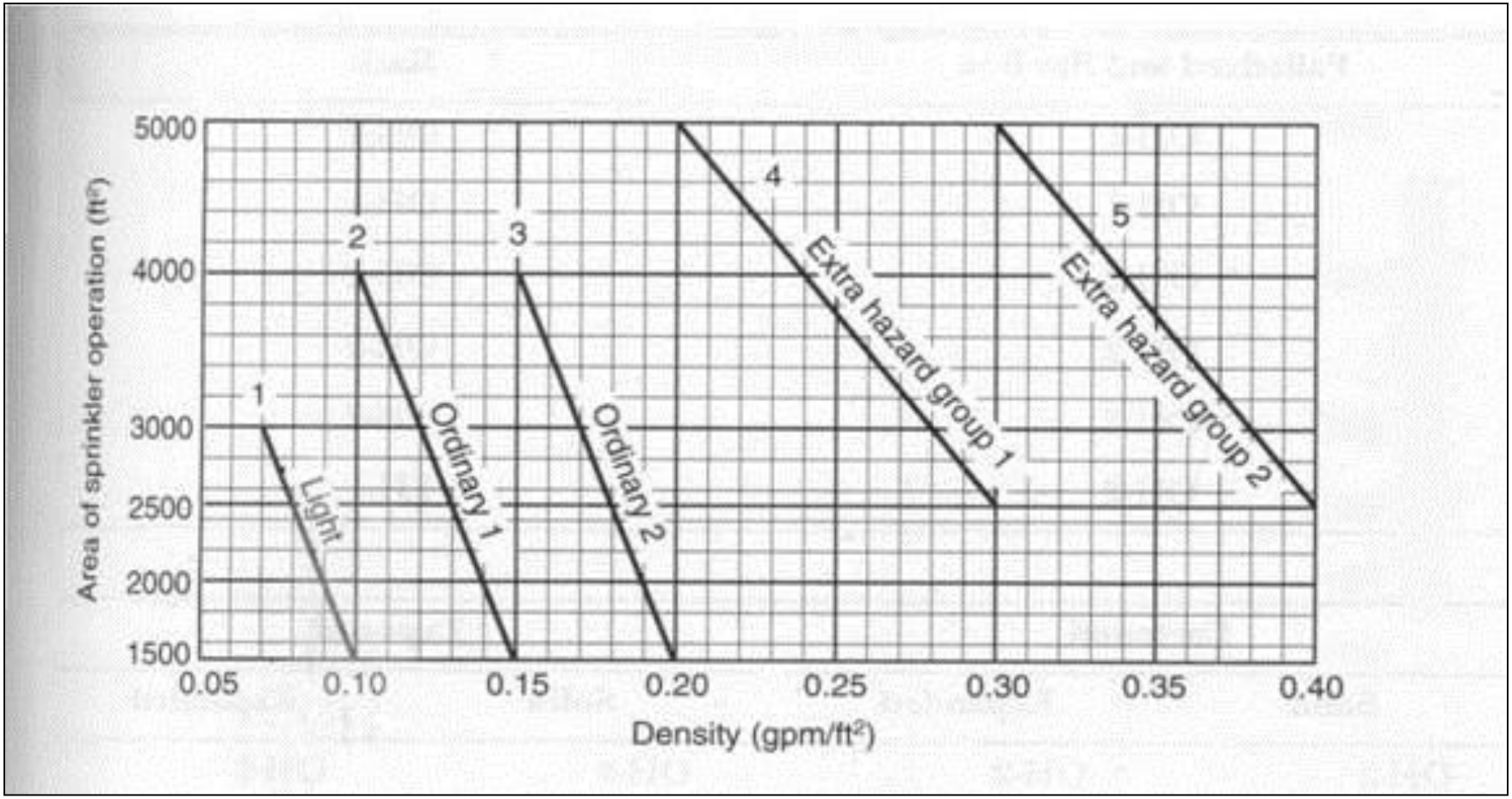
Steps to Completing Sprinkler Layout

- Step 1: Classify the building in terms of occupancies
  - Classify by fire areas of the building
    - Light Hazard Occupancy – Building or portion that has low quantities of flammable/combustible contents
    - Ordinary Hazard (Group 1) – Combustibility is low. Quantities of materials is moderate, stockpiles do not exceed 8 feet
    - Ordinary Hazard (Group 2) – Combustibility is low. Quantities of materials is moderate to high, stockpiles do not exceed 12 feet
    - Extra Hazard (Group 1) - Quantity and combustibility of materials is very high, dusts, lint present
    - Extra Hazard (Group 2) Moderate to substantial amounts of flammable liquids are present

Steps to Completing Sprinkler Layout

- Step 2: Determine water density from density curve
  - The Area of Operation from the curve is the maximum area in square feet a fire would expected to spread to under the sprinkler system design criteria
  - Using this area and building classification, a density is obtained
  - Using this density multiplied by the area of operation, a water demand in GPM is derived

Density Curve



Sprinkler System Water Demands

- With the water demand calculated for the sprinkler system in GPM and the density, the sprinkler system is laid out meeting proper spacing requirements
- Ultimately, the GPM per sprinkler head is determined for the heads in the area of operation (area of operation is established furthest from the riser, also referred to as "most remote")

Number of Heads and Location of Design Area

- To determine the number of heads to calculate and the design area, use:
  - Total Number of Heads = (Design Area)/(Coverage area per sprinkler)
- Go to most remote area and identify the correct heads that would have to be hydraulically calculated.

Water Demands at Sprinkler Head

- Minimum water demand (Q) at the most remote head must meet (max coverage per head)(density from density curve)
  - "Most remote" means furthest from the riser in linear distance
- Q = (max coverage per head) * (Density from density curve)

Water Pressure Demands

- The required water pressure at the most remote head is determined by:
- $P = (Q / K)^2$
  - P= Pressure in PSI
  - Q =water flow at the sprinkler head
  - K = K factor for the particular type of sprinkler head
    - K Factors give an indication as to the size of the orifice on the head which is related to the gpm that can flow out of the head

Steps to Completing the Sprinkler Layout

- Step 3: Using the building classification and design density, determine maximum spacing between sprinkler heads and between branch lines
- Also be sure to meet:
  - Maximum distances between sprinklers
  - Maximum distances from walls (1/2 maximum distance between sprinklers)
  - Minimum distance to walls (4 inches)
  - Minimum distance between sprinklers (6 feet)

Steps to Completing the Sprinkler Layout

- Step 4: Verify spacing does not exceed area of protection for each head (A = S X L)
  - Where Area = Distance between sprinkler heads X distance between branch lines

maintenance.

8.2 System Protection Area Limitations.

8.2.1 The maximum floor area on any one floor to be protected by sprinklers supplied by any one sprinkler system riser or combined system riser shall be as follows:

(1) Light hazard — 52,000 ft^2 (4831 m^2)

(2) Ordinary hazard — 52,000 ft^2 (4831 m^2)

(3) Extra hazard

(a) Pipe schedule — 25,000 ft^2 (2323 m^2)

(b) Hydraulically calculated — 40,000 ft^2 (3716 m^2)

(4) Storage — High-piled storage (as defined in 3.9.1.13) and storage covered by other NFPA standards — 40,000 ft^2 (3716 m^2)

8.2.2 The floor area occupied by mezzanines shall not be included in the area limits of 8.2.1.

8.2.3 Where single systems protect extra hazard, high-piled storage, or storage covered by other NFPA standards, and ordinary or light hazard areas, the extra hazard or storage area

Table 5-6.2.2(a) Protection Areas and Maximum Spacing (Standard Spray Upright/Standard Spray Pendent) for Light Hazard

Construction Type	System Type	Protection Area		Spacing (maximum)	
		ft^2	m^2	ft	m
Noncombustible obstructed and unobstructed and combustible unobstructed	Pipe schedule	200	18.6	15	4.6
	Hydraulically calculated	225	20.9	15	4.6
Combustible obstructed	All	168	15.6	15	4.6
Combustible with members less than 3 ft on center	All	130	12.1	15	4.6

Table 5-6.2.2(b) Protection Areas and Maximum Spacing (Standard Spray Upright/Standard Spray Pendent) for Ordinary Hazard

Construction Type	System Type	Protection Area		Spacing (maximum)	
		ft^2	m^2	ft	m
All	All	130	12.1	15	4.6

Table 5-6.2.2(c) Protection Areas and Maximum Spacing (Standard Spray Upright/Standard Spray Pendent) for Extra Hazard

Construction Type	System Type	Protection Area		Spacing (maximum)	
		ft^2	m^2	ft	m
All	Pipe schedule	90	8.4	12	3.7
				[In buildings with storage bays 25 ft (7.6 m) wide, 12 ft 6 in. (3.8 m) shall be permitted]	
All	Hydraulically calculated with density ≥0.25	100	9.3	12	3.7
				[In buildings with storage bays 25 ft (7.6 m) wide, 12 ft 6 in. (3.8 m) shall be permitted]	
All	Hydraulically calculated with density <0.25	130	12.1	15	4.6

$$A_s = S \times L$$

8.7.2.2 Maximum Protection Area of Coverage.

8.7.2.2.1 The maximum allowable protection area of coverage for a sprinkler (A_s) shall be in accordance with the value indicated in Table 8.7.2.2.1.

Table 8.7.2.2.1 Protection Areas and Maximum Spacing (Standard Sidewall Spra

	Light Hazard		Ordina
	Combustible Finish	Noncombustible or Limited-Combustible Finish	Combustible Finish
Maximum distance along the wall *(S)*	14 ft	14 ft	10 ft
Maximum room width *(L)*	12 ft	14 ft	10 ft
Maximum protection area	120 ft^2	196 ft^2	80 ft^2

For SI units, 1 ft = 0.3048 m; 1 ft^2 = 0.0929 m^2.

8.7.2.2.2 In any case, the maximum area of coverage of a sprinkler shall not exceed 196 ft^2 (18.2 m^2).

8.12.2.2 Maximum Protection Area of Coverage.

8.12.2.2.1 The maximum allowable protection area of coverage for a sprinkler *(A_s)* shall be in accordance with the value indicated in Table 8.12.2.2.1.

Table 8.12.2.2.1 Protection Areas and Maximum Spacing of ESFR Sprinkle

	Ceiling/Roof Heights Up to 30 ft (9.1 m)				Ceiling/Roof Heights C	
	Protection Area		Spacing		Protection Area	
Construction Type	**ft²**	**m²**	**ft**	**m**	**ft²**	**m²**
Noncombustible unobstructed	100	9.3	12	3.7	100	9.3
Noncombustible obstructed	100	9.3	12	3.7	100	9.3
Combustible unobstructed	100	9.3	12	3.7	100	9.3
Combustible obstructed	N/A		N/A		N/A	

8.12.2.2.2 Unless the requirements of 8.12.2.2.3 are met, the maximum area of coverage of any sprinkler shall not exceed 100 ft² (9.3 m²).

8.12.2.2.3* It shall be permitted to deviate from the maximum sprinkler spacing to eliminate

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8.11.2* Protection Areas per Sprinkler (Large Drop Spri

8.11.2.1 Determination of the Protection Area of Covera
coverage per sprinkler (A_s) shall be determined in accordanc

8.11.2.2 Maximum Protection Area of Coverage.

8.11.2.2.1 The maximum allowable protection area of cover
in accordance with the value indicated in Table 8.11.2.2.1.

Table 8.11.2.2.1 Protection Areas and Maximum Spacing for Large Drop Sprinklers

Construction Type	Protection Area		Maximum Spacing	
	ft²	m²	ft	m
Noncombustible unobstructed	130	12.1	12	3.7
Noncombustible obstructed	130	12.1	12	3.7
Combustible unobstructed	130	12.1	12	3.7
Combustible obstructed	100	9.3	10	3.1
Rack storage applications	100	9.3	10	3.1

8.11.2.2.2 In any case, the maximum area of coverage of an
ft² (12.9 m²).

8.11.2.3 Minimum Protection Area of Coverage. The min
of coverage for a sprinkler (A_s) shall be not less than 80 ft² (

8.11.3 Sprinkler Spacing (Large Drop Sprinklers).

8.11.3.1* Maximum Distance Between Sprinklers.

8.9.2.1.2 Listing dimensions shall be in 2 ft (0.61 m) increments up to 28 ft (8.5 m).

8.9.2.2 Maximum Protection Area of Coverage.

8.9.2.2.1 The maximum allowable protection area of coverage for a sprinkler (A_s) shall be in accordance with the value indicated in Table 8.9.2.2.1.

Table 8.9.2.2.1 Protection Area and Maximum Spacing for Extended Coverage Sidewal Sprinklers

	Light Hazard				Ordinary Hazard			
	Protection Area		Spacing		Protection Area		Spacing	
Construction Type	ft²	m²	ft	m	ft²	m²	ft	m
Unobstructed, smooth, flat	400	37.2	28	8.5	400	37.2	24	7.3

8.9.2.2.2 In any case, the maximum area of coverage of a sprinkler shall not exceed 400 ft² (37.2 m²).

8.9.3 Sprinkler Spacing (Extended Coverage Sidewall Spray Sprinklers).

8.9.3.1 Maximum Distance Between Sprinklers.

8.9.3.1.1 The maximum distance permitted between sprinklers shall be based on the centerline distance between sprinklers on the branch line along the wall

Table 8.8.2.1.2 Protection Areas and Maximum Spacing (Extended Coverage Upright Spray Sprinklers)

	Light Hazard		Ordinary Hazard		Extra Hazard		H
Construction Type	Protection Area (ft^2)	Spacing (ft)	Protection Area (ft^2)	Spacing (ft)	Protection Area (ft^2)	Spacing (ft)	Pr
Unobstructed	400	20	400	20	—	—	
	324	18	324	18	—	—	
	256	16	256	16	—	—	
	—	—	196	14	196	14	
	—	—	144	12	144	15	
Obstructed noncombustible (when specifically listed for such use)	400	20	400	20	—	—	
	324	18	324	18	—	—	
	256	16	256	16	—	—	
	—	—	196	14	196	14	
	—	—	144	12	144	15	
Obstructed combustible	N/A	N/A	N/A	N/A	N/A	N/A	

For SI units, 1 ft = 0.3048 m; 1 ft^2 = 0.0929 m^2.

manufacturer symbol, followed by three or four numbers, so as to identify a unique sprinl identification for every change in orifice size or shape, deflector characteristic, pressure rating, and thermal sensitivity.

6.2.3 Sprinkler Discharge Characteristics.

6.2.3.1* General. Unless the requirements of 6.2.3.2, 6.2.3.3, or 6.2.3.4 are met, the K-factor, relative discharge, and marking identification for sprinklers having different orif sizes shall be in accordance with Table 6.2.3.1.

Table 6.2.3.1 Sprinkler Discharge Characteristics Identification

Nominal K-factor [gpm/(psi)$^{1/2}$]	K-factor Range [gpm/(psi)$^{1/2}$]	K-factor Range [dm^3/min/(kPa)$^{1/2}$]	Percent of Nominal K-5.6 Discharge	Thread Type
1.4	1.3–1.5	1.9–2.2	25	½ in. NPT
1.9	1.8–2.0	2.6–2.9	33.3	½ in. NPT
2.8	2.6–2.9	3.8–4.2	50	½ in. NPT
4.2	4.0–4.4	5.9–6.4	75	½ in. NPT
5.6	5.3–5.8	7.6–8.4	100	½ in. NPT
8.0	7.4–8.2	10.7–11.8	140	¾ in. NPT or ½ in. NPT
11.2	11.0–11.5	15.9–16.6	200	½ in. NPT or ¾ in. NPT
14.0	13.5–14.5	19.5–20.9	250	¾ in. NPT
16.8	16.0–17.6	23.1–25.4	300	¾ in. NPT
19.6	18.6–20.6	27.2–30.1	350	1 in. NPT
22.4	21.3–23.5	31.1–34.3	400	1 in. NPT
25.2	23.9–26.5	34.9–38.7	450	1 in. NPT
28.0	26.6–29.4	38.9–43.0	500	1 in. NPT

6.2.3.2 Pipe Threads. Listed sprinklers having pipe threads different from those shown i Table 6.2.3.1 shall be permitted.

6.2.3.3 K-Factors Greater Than 28. Sprinklers listed with nominal K-factors greater th 28 shall increase the flow by 100 percent increments when compared with a nominal K-5 sprinkler.

6.2.3.4 Residential Sprinklers. Residential sprinklers shall be permitted with K-factors other than those specified in Table 6.2.3.1.

6.2.3.5 Large Drop and ESFR K-Factors. Large drop and ESFR sprinklers shall have a minimum nominal K-factor of 11.2.

6.2.3.6 ESFR Orifice Size. ESFR sprinkler orifice size shall be selected as appropriate f

in Table 11.2.3.1.2.

Table 11.2.3.1.2 Hose Stream Allowance and Water Supply Duration Requirements for Hydraulically Calculated Systems

Occupancy	Inside Hose		Total Combined Inside and Outside Hose		Duration (minutes)
	gpm	L/m	gpm	L/m	
Light hazard	0, 50, or 100	0, 189, 379	100	379	30
Ordinary hazard	0, 50, or 100	0, 189, 379	250	946	60–90
Extra hazard	0, 50, or 100	0, 189, 379	500	1893	90–120

11.2.3.1.3 The lower duration values in Table 11.2.3.1.2 shall be permitted where the sprinkler system waterflow alarm device(s) and supervisory device(s) are electrically

11.2.2 Water Demand Requirements — Pipe Schedule Method.

11.2.2.1 Table 11.2.2.1 shall be used in determining the minimum water supply requirements for light and ordinary hazard occupancies protected by systems with pipe sized according to the pipe schedules of Section 22.5.

Table 11.2.2.1 Water Supply Requirements for Pipe Schedule Sprinkler Systems

Occupancy Classification	Minimum Residual Pressure Required		Acceptable Flow at Base of Riser (Including Hose Stream Allowance)		Duration (minutes)
	psi	bar	gpm	L/min	
Light hazard	15	1	500–750	1893–2839	30–60
Ordinary hazard	20	1.4	850–1500	3218–5678	60–90

11.2.2.2 Pressure and flow requirements for extra hazard occupancies shall be based on the hydraulic calculation methods of 11.2.3.

11.2.2.3 The pipe schedule method shall be permitted only for new installations of 5000 ft^2 (465 m^2) or less or for additions or modifications to existing pipe schedule systems sized according to the pipe schedules of Section 22.5.

22.5.2.2.1 Pipe sizes shall be in accordance with Table 22.5.2.2.1.

Table 22.5.2.2.1 Light Hazard Pipe Schedules

Steel		Copper	
1 in.	2 sprinklers	1 in.	2 sprinklers
1¼ in.	3 sprinklers	1¼ in.	3 sprinklers
1½ in.	5 sprinklers	1½ in.	5 sprinklers
2 in.	10 sprinklers	2 in.	12 sprinklers
2½ in.	30 sprinklers	2½ in.	40 sprinklers
3 in.	60 sprinklers	3 in.	65 sprinklers
3½ in.	100 sprinklers	3½ in.	115 sprinklers
4 in.	See Section 8.2	4 in.	See Section 8.2

For SI units, 1 in. = 25.4 mm.

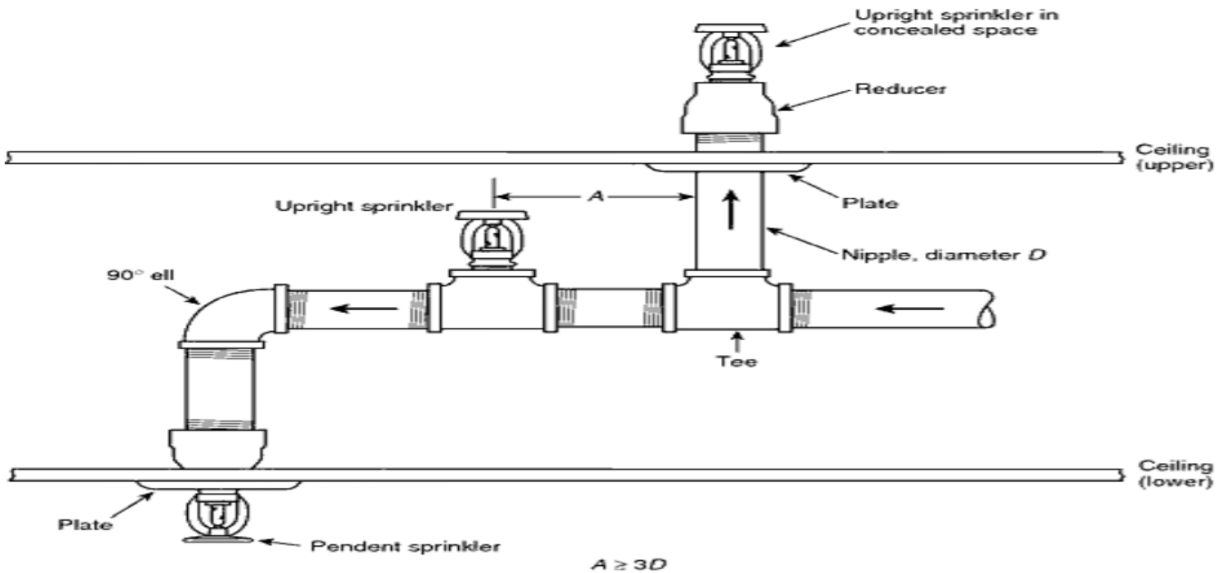

FIGURE 22.5.2.3(c) Arrangement of Branch Lines Supplying Sprinklers Above, in Between, and Below Ceilings.

22.5.2.4 Unless the requirements of 22.5.2.5 are met, pipe sizing up to and including 2 ½ in. (64 mm) shall be as shown in Table 22.5.2.4 utilizing the greatest number of sprinklers to be found on any two adjacent levels.

Table 22.5.2.4 Number of Sprinklers Above and Below a Ceiling

Steel		Copper	
1 in.	2 sprinklers	1 in.	2 sprinklers
1¼ in.	4 sprinklers	1¼ in.	4 sprinklers
1½ in.	7 sprinklers	1½ in.	7 sprinklers
2 in.	15 sprinklers	2 in.	18 sprinklers
2½ in..	50 sprinklers	2½ in.	65 sprinklers

For SI units, 1 in. = 25.4 mm.

22.5.2.5 Branch lines and cross mains supplying sprinklers installed entirely above or entirely below ceilings shall be sized in accordance with Table 22.5.2.2.1.

22.5.2.6* Where the total number of sprinklers above and below a ceiling exceeds the number specified in Table 22.5.2.2.1 for 2½ in. (64 mm) pipe, the pipe supplying such

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a 2½ in. (64 mm) pipe.

22.5.3.4 Pipe sizes shall be in accordance with Table 22.5.3.4.

Table 22.5.3.4 Ordinary Hazard Pipe Schedule

Steel		Copper	
1 in.	2 sprinklers	1 in.	2 sprinklers
1¼ in.	3 sprinklers	1¼ in.	3 sprinklers
1½ in.	5 sprinklers	1½ in.	5 sprinklers
2 in.	10 sprinklers	2 in.	12 sprinklers
2½ in..	20 sprinklers	2½ in.	25 sprinklers
3 in.	40 sprinklers	3 in.	45 sprinklers
3½ in.	65 sprinklers	3½ in.	75 sprinklers
4 in.	100 sprinklers	4 in.	115 sprinklers
5 in.	160 sprinklers	5 in.	180 sprinklers
6 in.	275 sprinklers	6 in.	300 sprinklers
8 in.	See Section 8.2	8 in.	See Section 8.2

For SI units, 1 in. = 25.4 mm.

22.5.3.5 Where the distance between sprinklers on the branch line exceeds 12 ft (3.7 m) or the distance between the branch lines exceeds 12 ft (3.7 m), the number of sprinklers for a given pipe size shall be in accordance with Table 22.5.3.5.

Table 22.5.3.5 Number of Sprinklers — Greater Than 12 ft (3.7 m) Separations

Steel		Copper	
2½ in.	15 sprinklers	2½ in	20 sprinklers
3 in.	30 sprinklers	3 in.	35 sprinklers
3½ in.	60 sprinklers	3½ in.	65 sprinklers

For SI units, 1 in. = 25.4 mm.

Note: For other pipe and tube sizes, see Table 22.5.3.4.

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cross main, such branch lines shall not exceed eight sprinklers above and eight sprinklers below any ceiling on either side of the cross main.

22.5.3.7 Pipe sizing up to and including 3 in. (76 mm) shall be as shown in Table 22.5.3.7 in accordance with Figure 22.5.2.3(a), Figure 22.5.2.3(b), and Figure 22.5.2.3(c) utilizing the greatest number of sprinklers to be found on any two adjacent levels.

Table 22.5.3.7 Number of Sprinklers Above and Below a Ceiling

Steel		Copper	
1 in.	2 sprinklers	1 in.	2 sprinklers
1¼ in.	4 sprinklers	1¼ in.	4 sprinklers
1½ in.	7 sprinklers	1½ in.	7 sprinklers
2 in.	15 sprinklers	2 in.	18 sprinklers
2½ in.	30 sprinklers	2½ in.	40 sprinklers
3 in.	60 sprinklers	3 in.	65 sprinklers

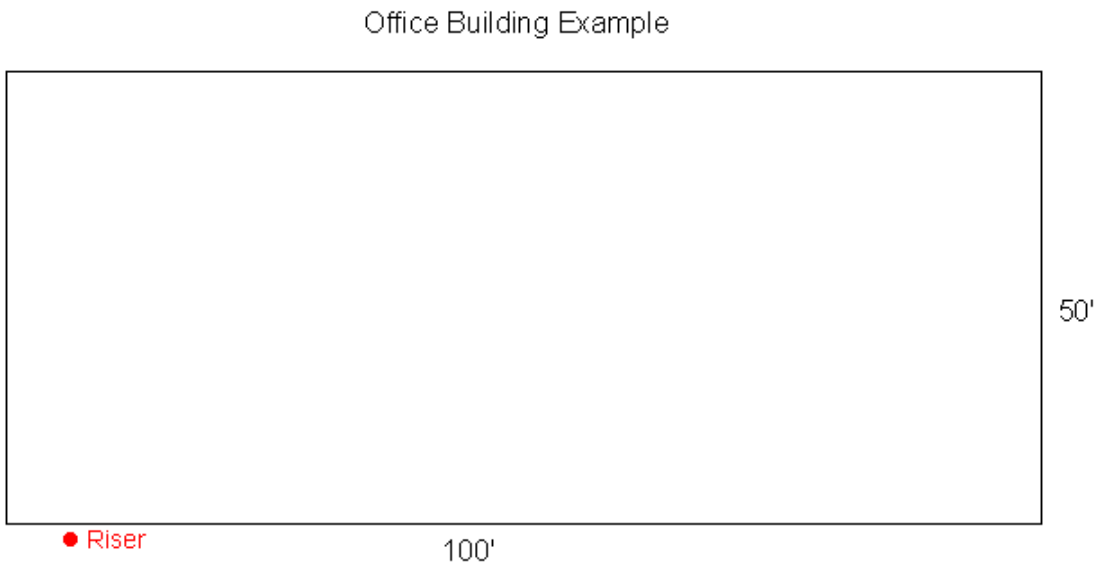
For SI units, 1 in. = 25.4 mm.

22.5.3.8 Branch lines and cross mains supplying sprinklers installed entirely above or entirely below ceilings shall be sized in accordance with Table 22.5.3.4 or Table 22.5.3.5.

Office Building Example

- An office building is 100’ by 50’
- Classified as a light hazard occupancy
- The designer selects a design Area of Operation of 1,500 square feet
  - This means the hydraulic calculations will ensure the sprinkler system is capable of operating effectively provided the fire is contained to 1,500 square feet at the most remote area of the building

Office Building Floor Plan

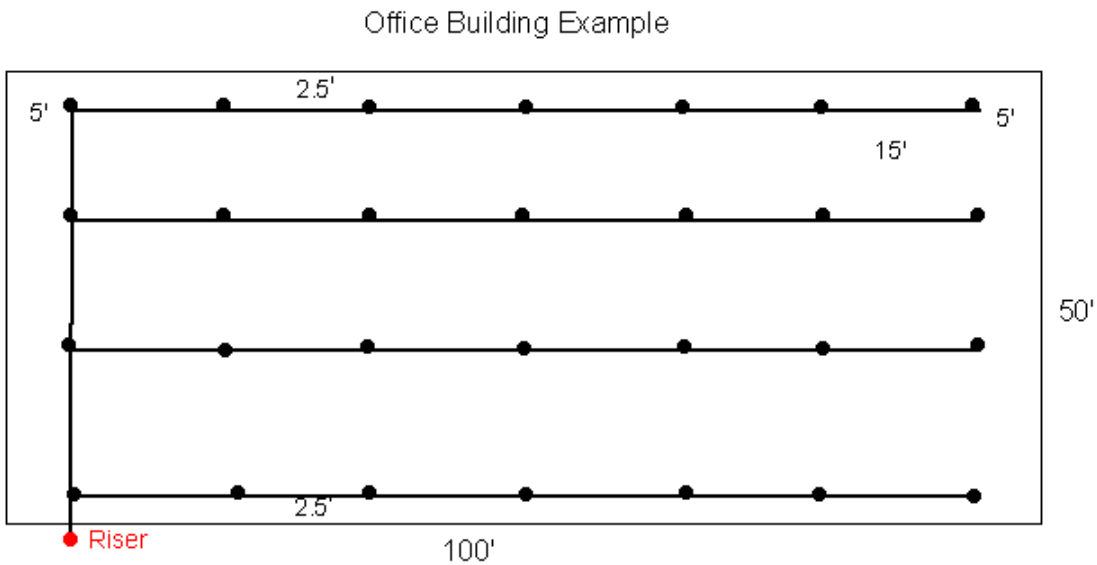


Classification: Light Hazard
Designer selected a design Area of Operation of 1,500 ft^2
Area/density curve indicates a density of .10 gpm/ft^2

Office Building Example

- The riser location is identified
- This is the location where the water for the sprinkler system enters the building
- Minimum and maximum distances for sprinkler heads and branch lines are determined
- The sprinkler system is planned out
- Confirm, each head is not required to cover more square footage than its max coverage
  - Distance between sprinkler heads X Distance between branch lines may not exceed the maximum coverage per head
  - In our example, 15' between heads X 15' between branch lines = 225 square feet which is equal to the max coverage for one head which is 225 square feet

Office Building Example



Classification: Light Hazard
Designer selected a design Area of Operation of 1,500 ft^2
Maximum distance between heads and branchlines: 15'
Minimum distance between heads and branchlines: 6'
Minimum distance to walls: 4" Maximum distance from walls: 7.5'

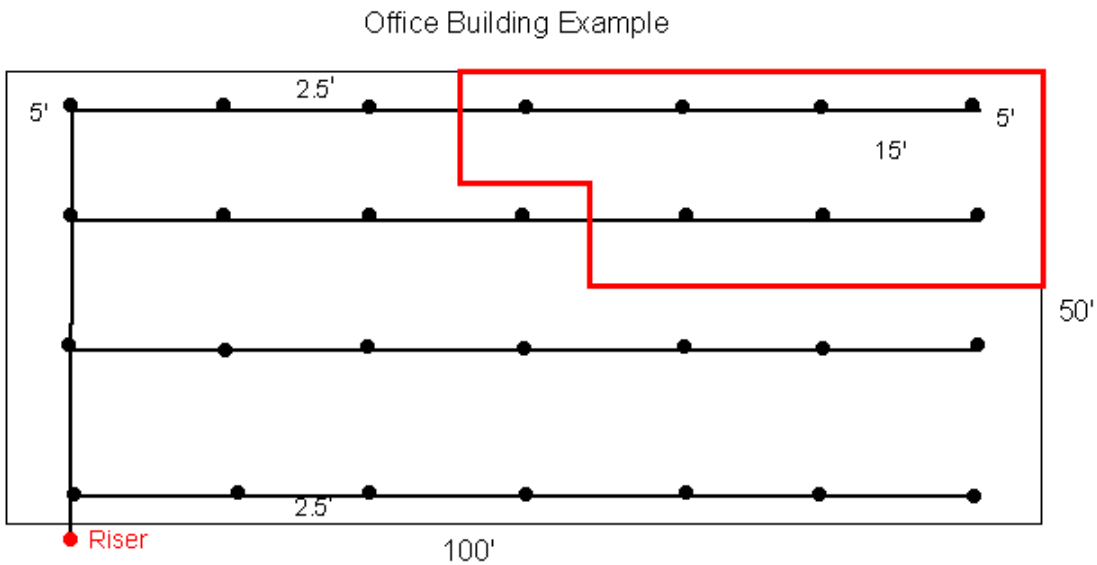
Office Building Example

- Number of Heads and Location of Design Area
- To determine the number of heads to calculate and the design area, use:
  - Total Number of Heads = (Design Area)/(Coverage area per sprinkler)
- Go to most remote area and identify the correct heads that would have to be hydraulically calculated.

Office Building Example

- Example: In a light hazard occupancy with a selected design area of operation of 1,500 square feet:
- Total Number of Heads to Calculate = (1,500)/(225) = 6.7 or approx 7 heads
  - Note: If you calculate your true area of operation for these 7 heads, your building area of protection area is only 1,213 square feet which is more conservative than the 1,500 square feet the 7 heads could be required to protect

Office Building Example



Classification: Light Hazard
Designer selected a design Area of Operation of 1,500 ft^2
Area/density curve indicates a density of .10 gpm/ft^2
Total Heads = Design Area/Area per head
Total Heads = 1,500/225 = 6.7 or approx 7 heads

Water Demands at Sprinkler Head

- Minimum water demand (Q) at the most remote head must meet (max coverage per head)(density from density curve)
- Q = (max coverage per head) * (Density from density curve)
- Example: For a light hazard occupancy with a design area of protection of 1,500 square feet, using pendant head sprinklers:
  - Q = (225 square feet) * (.10 gpm/ square foot) = 22.5 gpm minimum for each sprinkler head

Water Demand for the Design Area of Protection

- Selected an area of 1,500 square feet
- Light Hazard Occupancy
- The density on the curve is .10 gpm/square foot
- Total water demand for the design Area of Protection is (1,500)*(.10) = 150 gpm
- We would hydraulically calculate 7 heads at 22.5 gpm which would produce 157.5 gpm
- We would be ensuring our sprinkler system can meet 157.5 gpm which is a higher standard than the 150 gpm

Water Pressure Demands

- Using $P = (Q / K)^2$
  - P= Pressure in PSI
  - Q =water flow at the sprinkler head
  - K = K factor for the particular type of sprinkler head
  - The designer selected a pendent sprinkler head with a K Factor of 5.6.
  - The designer determined the minimum water flow for a sprinkler head in this system is 22.5 gpm, therefore:
    - $P = (22.5/5.6)^2 = 16.1$ psi
  - The minimum water pressure required at the most remote head in the system is 16.1 psi.

Additional Steps

- To ensure the sprinkler system will work properly, hydraulic calculations would be performed to ensure that when all heads in our area of protection are opened at once, there is adequate water pressure (in psi) and water flow (in gpm) at the riser.
  - If our calculated required pressure is more than the water pressure found at the riser, then changes need to be implemented

Why examine only the most remote area?

- The logic of examining only the set number of heads at the most remote portion of the building is as follows:
  - Keeping pipe diameters and minimum water flow requirements the same throughout the building, because of physics and hydraulics, if the minimum required water pressure and gpm are met at the most remote section of the building, as you move closer to the riser, water pressure and gpm will automatically be greater

Portable Extinguishers NFPA 10

Terminal Objective

The Firefighter I candidate shall correctly identify in writing the classifications of fire as they relate to the use of fire extinguishers, and shall define the fire [illegible]

[illegible]

appropriate extinguisher and demonstrate its use [illegible]

The Firefighter I candidate shall also correctly demonstrate extinguishing a Class A and Class B fire using appropriate portable fire extinguishers

Importance Of Fire Extinguishers

- Fire extinguishers are the most readily available firefighting tool to firefighters.
- Firefighters can better educated the public on the importance of fire extinguishers.
- Fire extinguishers are excellent for small incipient phase fires.
- Fire extinguishers are easier and faster to deploy

CLASSES OF FUEL OR FIRES

A

Class A

- Ordinary Combustibles

B

Class B

- Flammable Liquid and Gases

C

Class C

- Live Electrical Equipment

D

Class D

- Combustible Metals

Class A Fires

- Ordinary combustibles such as wood, cloth rubber, many plastics.
- Water is used to cool the burning material below its ignition temperature.
- Class A foam can enhance the ability of water to extinguish deep seated class A fires due to reduction in surface tension.
- CO2 and other oxygen exclusion methods do not work effectively because of lack of a cooling effect

Class B Fires

- Flammable liquids such as gasoline, lacquer thinner, mineral spirits, and alcohol.
- The smothering or blanketing effect of oxygen exclusion is most effective for extinguishment and vapor suppression.
- Fuel removal is can also be used.
- Interruption of the chemical chain reaction can be used with a dry chemical agent such as Purple K.

Class C Fires

- Involves energized electrical equipment such as appliances, computers, transformers and overhead transmission lines.
- Use non-conducting agents such as Halon, Dry Chemical, or Carbon Dioxide.
- The fastest method may be to de-energize the electrical circuit and then fight fire appropriately depending on the fuel involved.

Class D Fires

- Involve combustible metals such as aluminum, magnesium, titanium, zirconium, potassium and sodium.
- Combustible metals are very hazardous in their powdered form and can cause powerful explosions.
- No single agent effectively controls fires in all combustible metals.
- Review MSDS and North American ERG.

Portable Extinguisher Rating System

Fire Extinguisher Ratings

- Class A Extinguisher – Rated 1A – 40 A.
- Class B Extinguisher – Rated 1B – 640 B.
- Class C Extinguisher – Rated for non-conductivity.
- Class D Extinguisher – Rated

EXTINGUISHER RATING SYSTEM

LETTERS indicate the fuel class on which the extinguisher will be effective.

A	B	C	D
Ordinary Combustibles	Flammable Liquids	Electrical Equipment	Combustible Metals

NUMBERS indicate the relative effectiveness of the extinguisher:

For example,

- A 2-A extinguisher extinguishes twice as much fuel as a 1-A extinguisher.
- A 20-B extinguisher extinguishes 20 times as much fuel as a 1-B extinguisher.

Numbers are used with letters on Class A and Class B extinguishers only.

Class A Extinguisher

- Rated from 1-A through 40-A.
- Rating of Class A extinguishers is based on the amount of extinguishing agent and range of discharge.
- A 1-A extinguisher requires 1 ¼ gallons of water, and a 2-A requires 2 ½ gallons of water or

Class B Extinguisher

- Classified numerically from 1-B to 640-B.
- The rating is based on the approximate squared foot that a non-expert operator can extinguish.
- The non-expert can extinguish 1 square foot of fire for every numerical rating on the extinguisher

Class C Extinguisher

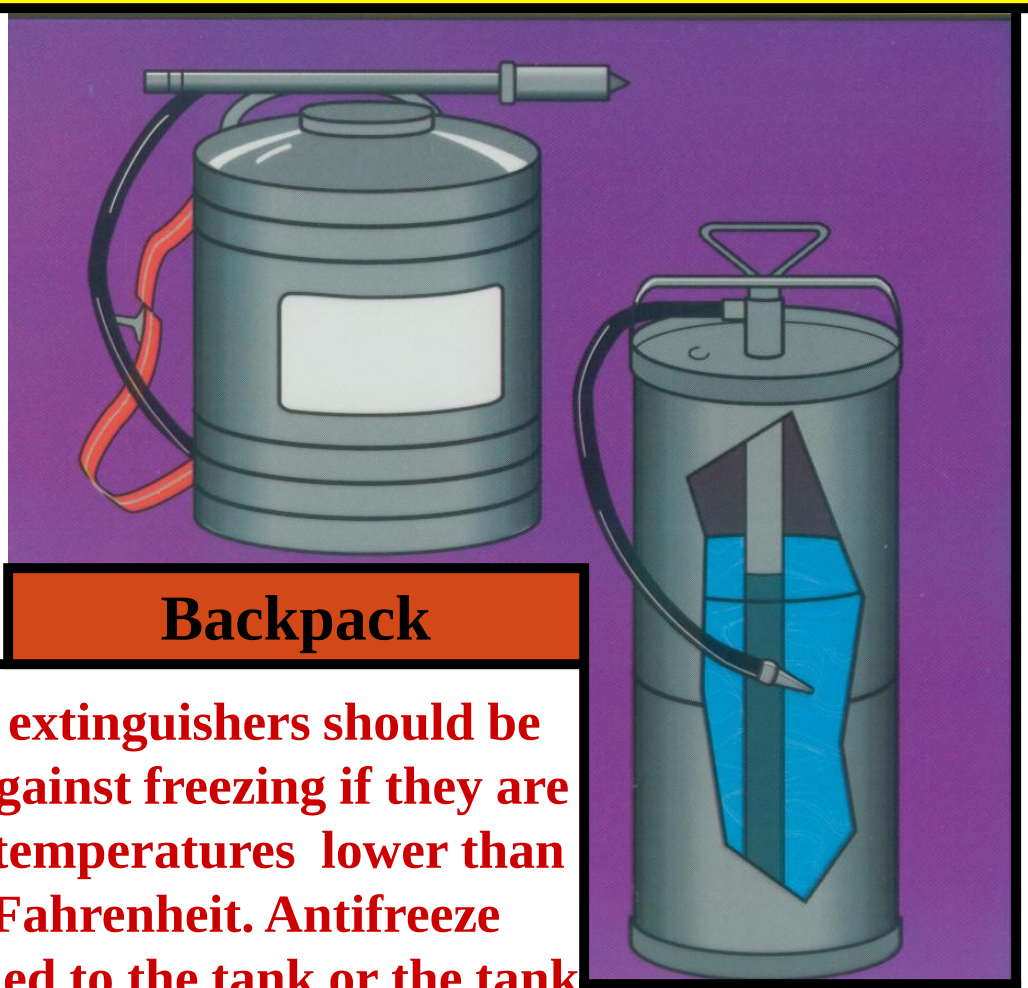
- There are no fire extinguishing capability tests conducted for Class C fires.
- The extinguishing material is tested only for non-conductivity.
- Class C fires are either Class A or Class B fires involving energized electrical equipment.
- An A B C rated extinguisher means that it will extinguish Class A and Class B fires and is non-conductive.

Class D Extinguishers

- Ratings are specific to the particular metal, the following factors are considered during testing of agents:
  - Reaction between the agent and the metal.
  - Toxicity of the agent.
  - Toxicity of the fumes produced and the products of combustion.
  - Time to allow for metal to burn out without fire suppression versus to extinguishment time.

Types OF Fire Extinguishers

Pump-Tank Water



Backpack

Pump Can

Vater-type extinguishers should be rotected against freezing if they are xposed to temperatures lower than 0 degrees Fahrenheit. Antifreeze nay be added to the tank or the tank an be stored in warm areas.

Application:

Class A Fires

Agent:

Water

Operating Principle:

Hand Pump

Size:

1 ½ gallon to 5 gallons

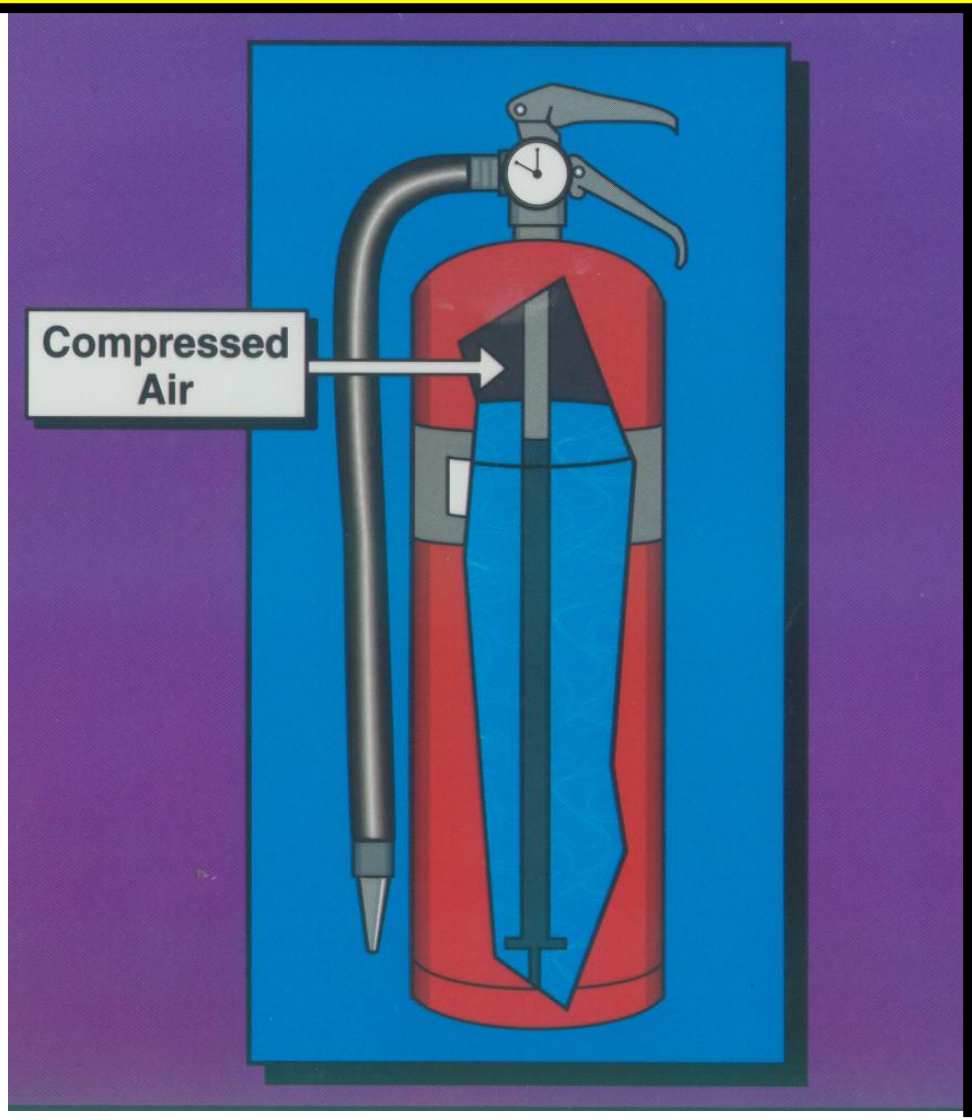
Stream Reach

30 – 40 feet

Discharge Time

45 Seconds to 3 Min.

Stored-Pressure Water



Application:

Class A Fires

Overhaul & Chimney

Agent:

Water /Class A Foam

Operating Principle:

Compressed Air

Nitrogen

Size:

1 ¼ to 2 ½ Gallons

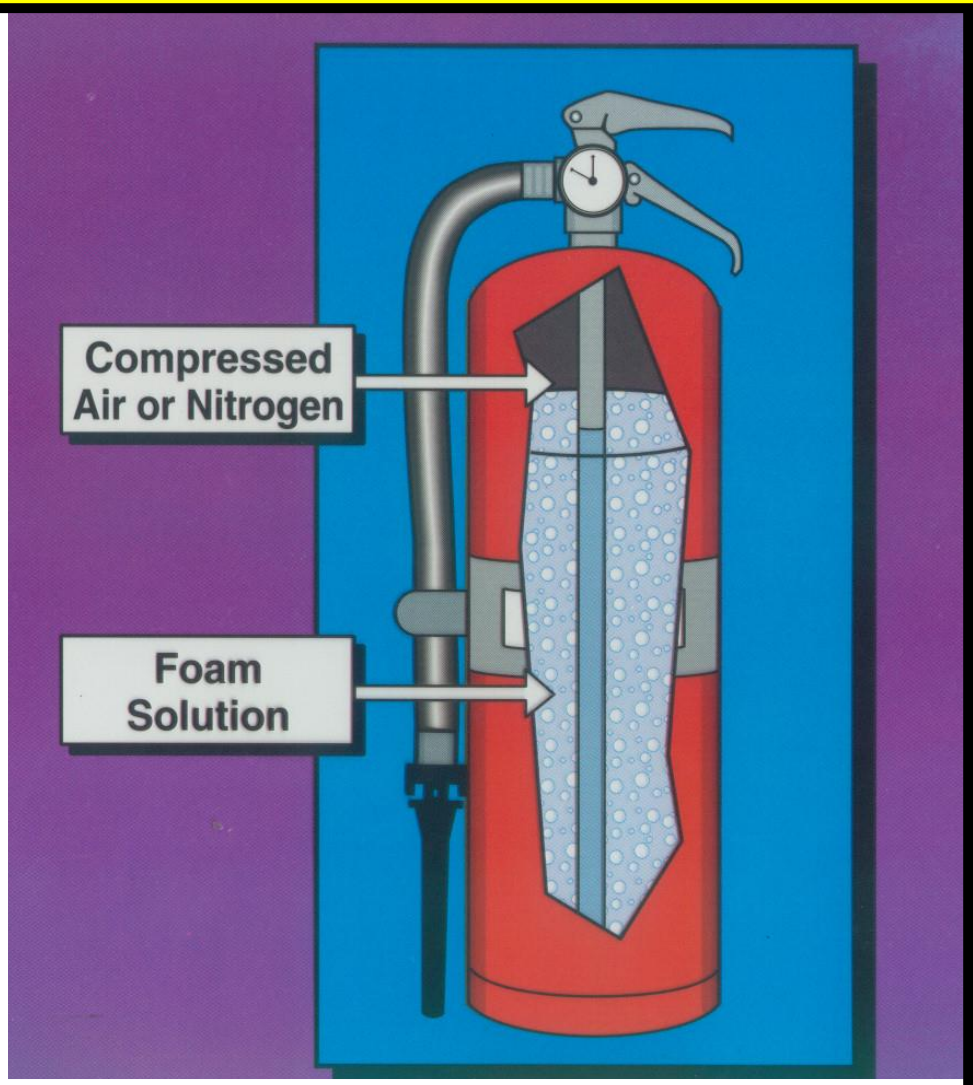
Stream Reach

30 – 40 feet

Discharge Time

30 – 60 Seconds

AFFF



Application:

Class A & B Fires

Agent:

Foam

Operating Principle:

Compressed Air

Nitrogen

Size:

2 ½ Gallon

Stream Reach

20 – 25 feet

Discharge Time

About 60 Seconds

AFFF Extinguishers

- Use on Class A and Class B fires.
- Excellent for vapor suppression on small liquid fuel spills.
- AFFF extinguishers store a specific amount of AFFF concentrate mixed with water.
- AFFF extinguishers have an air aspirating nozzle that aerates the foam solution producing a better foam than a standard water extinguisher nozzle.

AFFF Extinguishers

- When applying the foam, the stream should not be applied directly on the fuel.
- The foam should be allowed to gently rain down on the fuel or deflect off an object.
- The foam floats on the surface of fuel that are lighter than water.
- The vapor seal extinguishes fire and and prevents reignition.

AFFF Extinguishers

- The foam has good wetting and penetrating properties on Class A fuels, but is ineffective on water-soluble flammable liquids such as alcohol.
- They are not useful on Class C or D fuels.
- They are not suitable on three-dimensional like fuel flowing down from an elevated point or fuel being sprayed.
- They are most effective on static pools of flammable liquids.

Halon Extinguishers

- Halon is an ozone depleting extinguishing agent.
- There is an international agreement to phase out Halon (Montreal Protocol on Substances that Deplete the Ozone Layer).
- Halon can still be found in use.

Halon Extinguishers

- Halon is generic for halogenated hydrocarbon:
  - A chemical compound that contains carbon plus one or more elements from the halogen series (fluorine, chlorine, bromine, or iodine).
- The two most common compounds used are:
  - Halon 1211 (bromochlorodifluoromethane).
  - Halon 1301 (bromotrifluoromethane).

Halon Extinguishers

- Halon vapor is non-conductive and is effective on Class B and C fires.
- Halon was originally used to protect internal combustion engines, but is now used for sensitive electronic equipment (computers).
- Halon agents are not effective on self-oxidizing fuels such as:
  - Combustible metals.
  - Organic peroxides.
  - Metal hydrides.

Halon

Halon 1211

Hand Carried

2 – 20 lb.

Discharge Time:

8 – 18 Seconds

Wheeled - 150 lb.

Discharge Time:

30 – 44 Seconds

Halon 1301

Hand Carried

Total Flooding

2 ½ lb.

Discharge Time:

8 – 10 Seconds

Application:

Class B & C Fires

Agent:

1301or 1211

Operating Principle:

Liquefied Compressed Gas

Stream Reach

4 - 18 feet

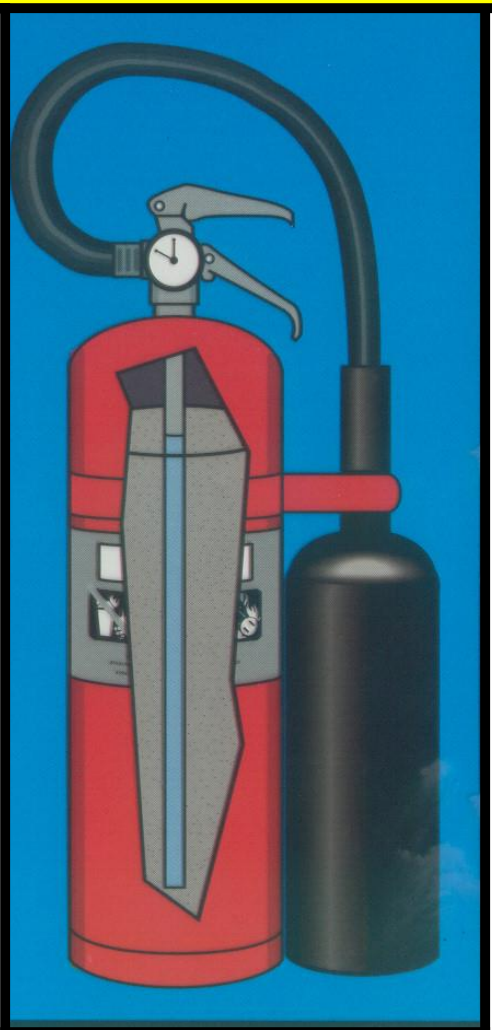
Carbon Dioxide

CO_2 Hand-Carried

2 ½ to 20 lbs.

CO_2 Wheeled Units

50 to 100 lbs.



Application:

Class B & C Fires

Agent:

Carbon Dioxide

Operating Principle:

Liquefied Compressed Gas

Stream Reach

Hand-carried – 3 to 8 feet

Wheeled – 8 to 10 feet

Discharge Time

Hand-carried – 8 to 30 seconds

Wheeled – 26 to 65 seconds

Carbon Dioxide Extinguisher

- Used for Class B and Class C fires.
- CO2 extinguishers' discharge is in the form of a gas, which gives it limited reach.
- The discharge is accompanied by ice crystals or "snow" which turns into a gas shortly after discharge.
- The CO gas displaces the available oxygen.

Carbon Dioxide Extinguisher

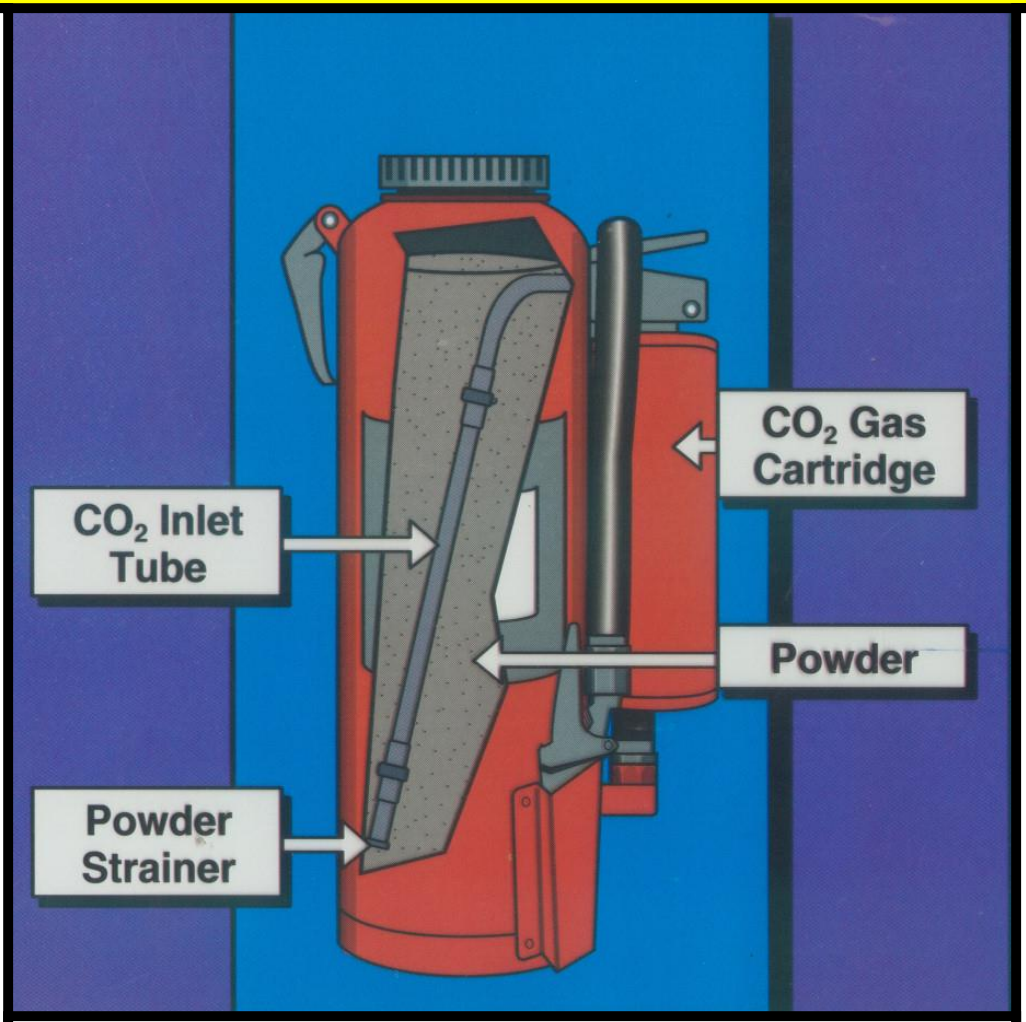
- There is no vapor suppression film, so reignition is a possibility.
- They do not require freeze protection.
- Wheeled units are mostly used in airports and industrial facilities.
- The typical CO 2 wheeled unit has a 15 foot long hose which has to be deployed for extinguishment.

What Is The Difference Between Dry Chemical And Dry Powder ?

Dry chemicals are used on Class A, Class B, or Class C fires.

Dry powders are used on Class D fires.

Dry Powder



Application:

Class D Fires

Agent:

Specific To Metal

Operating Principle:

Gas Cartridge

Stream Reach

4 To 6 Feet

Size

Hand-Carried 30lb.

Wheeled 150 to 350 lbs.

Discharge Time

Hand-Carried 28 to 30 Seconds

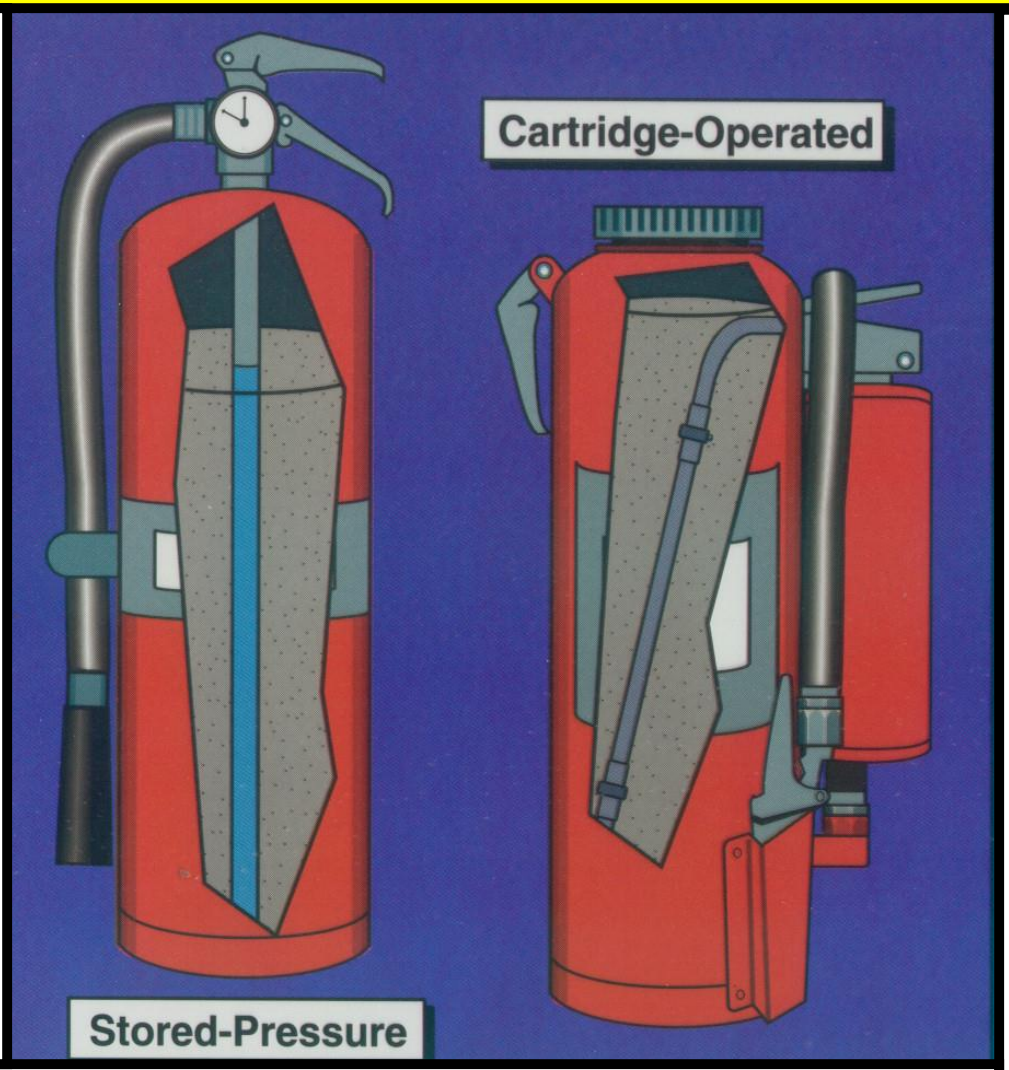
Dry Powder Extinguishers And Agents

- No single agent will control all combustible metal fires.
- Some agents will work on several metals, while some will work only on one metal.
- Portable extinguishers for Class D fires come in both wheeled and wheeled units.
- Other agents can be applied with a shovel.

Dry Powder Extinguishers And Agents

- Class D agents should be applied gently over the burning material at sufficient thickness to create a blanketing effect.
- Several applications may be necessary to hot spot that develop.
- After extinguishment, the metal should be allowed to cool before removal.

Dry Chemical



Application:

Class A B & C Fires or B & C Fires

Operating Principle:

Gas Cartridge or Stored Pressure

Size

2 ½ To 30 lbs.

Stream Reach

Hand-Carried Stored- Pressure or Cartridge; 5 to 20 feet

Discharge Time

8 to 25 Seconds

Dry Chemical Extinguishers

- There are two basic types of dry chemical extinguishers:
  - B:C rated
  - A:B:C: rated
- Common agents for dry chemicals extinguishers
  - Sodium bicarbonate
  - Potassium bicarbonate
  - Urea potassium bicarbonate
  - Potassium chloride
  - Monoammonium phosphate

Dry Chemical Extinguishers

- During manufacture, the agents are mixed with additives which prevent caking and maintain the agents in a free flowing manner.
- Dry chemicals are non-toxic but the cloud could create a respiratory hazard.
- Some dry chemicals are compatible with foam, but other will degrade it.

Dry Chemical Extinguishers

- On Class A fires, the discharge should be directed at the burning material in order to cover it.
- When the flames have been knocked down, the dry chemical agent should be applied intermittently as needed on hot spots.
- Dry chemical agents are corrosive on metals.

Dry Chemical Extinguishers (Handheld Units)

- Stored pressure.
  - Similar to stored-pressure water extinguisher.
  - Stored at 200 psi in tank.
  - Use CO2 or Nitrogen as the gas.
- Cartridge.
  - A gas cartridge is attached to the extinguisher.
  - The tank is not pressurized until the plunger is bumped.
  - Use CO2, or in areas subject to freezing, dry nitrogen.

Dry Chemical Extinguishers (Wheeled Units)

- Based on Class A, Class B, and Class C fires.
- Operates similar to the handheld cartridge type.
- The hose must be fully deployed before the pressurizing gas is introduced into the tank.
- Wait a few seconds before opening nozzle to allow the gas to fully pressurize the tank.

Dry Chemical Extinguishers (Wheeled Units)

Caution: The top of the extinguisher should be pointed away from the firefighter or other personnel when pressurizing the unit. Because of the size of the nozzle, the firefighter should be prepared for a significant nozzle reaction when it is opened.

Fire Extinguisher Values

- The three important factors that determine the value of a fire extinguisher:
  - Serviceability
  - Accessibility
  - User's ability to operate

Extinguisher Locations

NFPA 10 Chapter 3

3-1 General Requirements.

3-1.1*

The minimum number of fire extinguishers needed to protect a property shall be determined as outlined in this chapter. Frequently, additional extinguishers can be installed to provide more suitable protection. Fire extinguishers having ratings less than specified in Tables 3-2.1 and 3-3.1 can be installed, provided they are not used in fulfilling the minimum protective requirements of this chapter.

3-1.2*

Fire extinguishers shall be provided for the protection of both the building structure and the occupancy hazards contained therein.

3-1.2.1

Required building protection shall be provided by fire extinguishers suitable for Class A fires.

3-1.2.2*

Occupancy hazard protection shall be provided by fire extinguishers suitable for such Class A, B, C, D, or K fire potentials as might be present.

3-1.2.3

Fire extinguishers provided for building protection can be considered also for the protection of occupancies having a Class A fire potential.

3-1.2.4

Buildings having an occupancy hazard subject to Class B or Class C fires, or both, shall have a standard complement of Class A fire extinguishers for building protection, plus additional Class B or Class C fire extinguishers, or both. Where fire extinguishers have more than one letter classification (such as 2-A:20-B:C), they can be considered to satisfy the requirements of each letter class.

3-1.3

Rooms or areas shall be classified generally as light (low) hazard, ordinary (moderate) hazard, or extra (high) hazard. Limited areas of greater or lesser hazard shall be protected as required.

3-1.4

On each floor level, the area protected and the travel distances shall be based on fire extinguishers installed in accordance with Table

On each floor level, the area protected and the travel distances shall be based on fire extinguishers installed in accordance with Table 3-2.1 and Table 3-3.1.

3-2 Fire Extinguisher Size and Placement for Class A Hazards.

3-2.1

Minimal sizes of fire extinguishers for the listed grades of hazards shall be provided on the basis of Table 3-2.1, except as modified by 3-2.2. Fire extinguishers shall be located so that the maximum travel distances shall not exceed those specified in Table 3-2.1, except as modified by 3-2.2. (See Appendix E.)

Table 3-2.1 Fire Extinguisher Size and Placement for Class A Hazards

	Light (Low) Hazard Occupancy	Ordinary (Moderate) Hazard Occupancy	Extra (High) Hazard Occupancy
Minimum rated single extinguisher	2-A †	2-A †	4A *
Maximum floor area per unit of A	3000 ft2	1500 ft2	1000ft2
Maximum floor area for extinguisher	11,250 ft2 **	11,250 ft2 **	11,250 ft2 **
Maximum travel distance to extinguisher	75 ft	75 ft	75ft

For SI units: 1 ft = 0.305 m; 1 ft2 = 0.0929 m2

* Two 21/2-gal (9.46-L) water-type extinguishers can be used to fulfill the requirements of one 4-A rated extinguisher.

** See E-3.3.

† Up to two water-type extinguishers, each with 1-A rating, can be used to fulfill the requirements of one 2-A rated extinguisher.

3-2.1.1

Certain smaller fire extinguishers that are charged with a multipurpose dry chemical or a halogenated agent are rated on Class B and Class C fires, but have insufficient effectiveness to earn the minimum 1-A rating even though they have value in extinguishing smaller Class A fires. They shall not be used to meet the requirements of 3-2.1.

3-2.2

Up to one-half of the complement of fire extinguishers as specified in Table 3-2.1 shall be permitted to be replaced by uniformly spaced 11/2-in. (3.81-cm) hose stations for use by the occupants of the building. Where hose stations are so provided, they shall conform to NFPA 14, Standard for the Installation of Standpipe and Hose Systems. The location of hose stations and the placement of fire extinguishers shall be such that the hose stations do not replace more than every other fire extinguisher.

3-2.3

Where the area of the floor of a building is less than that specified in Table 3-2.1, at least one fire extinguisher of the minimum size recommended shall be provided.

3-2.4

The protection requirements shall be permitted to be fulfilled with fire extinguishers of higher rating, provided the travel distance to such larger fire extinguishers does not exceed 75 ft (22.7 m).

3-3* Fire Extinguisher Size and Placement for Class B Fires Other Than for Fires in Flammable Liquids of Appreciable Depth.

3-3.1

Minimal sizes of fire extinguishers for the listed grades of hazard shall be provided on the basis of Table 3-3.1. Fire extinguishers shall be located so that the maximum travel distances do not exceed those specified in the table used. (See Appendix E.)

Exception: Fire extinguishers of lesser rating, desired for small specific hazards within the general hazard area, can be used, but shall not be considered as fulfilling any part of the requirements of Table 3-3.1.

Table 3-3.1 Fire Extinguisher Size and Placement for Class B Hazard

Type of Hazard	Basic Minimum Extinguisher Rating	Maximum Travel Distance to Ext. (ft)	(m)
Light (low)	5-B	30	9.15
	10-B	50	15.25
Ordinary (moderate)	10-B	30	9.15
	20-B	50	19.25
Extra (high)	40-B	30	9.15
	80-B	50	15.25

Notes:

1. The specified ratings do not imply that fires of the magnitudes indicated by these ratings will occur, but rather they are provided to give the operators more time and agent to handle difficult spill fires that could occur.

2. For fires involving water-soluble flammable liquids, see 2-3.4.

3. For specific hazard applications, see Section 2-3.

3-3.2

Two or more fire extinguishers of lower rating shall not be used to fulfill the protection requirements of Table 3-3.1.

Exception No. 1: Up to three AFFF or FFFP fire extinguishers of at least 21/2-gal (9.46-L) capacity shall be permitted to be used to fulfill extra (high) hazard requirements.

Exception No. 2: Two AFFF or FFFP fire extinguishers of at least 11/2-gal (6-L) capacity shall be permitted to be used to fulfill ordinary (moderate) hazard requirements.

3-3.3

The protection requirements shall be permitted to be fulfilled with fire extinguishers of higher ratings, provided the travel distance to such larger fire extinguishers does not exceed 50 ft (15.25 m).

3-4* Fire Extinguisher Size and Placement for Class B Fires in Flammable Liquids of Appreciable Depth.

Exception: Where personnel who are trained in extinguishing fires in the protected hazards are available on the premises, the maximum surface area shall not exceed 20 ft2 (1.86 m2).

3-4.1*

Portable fire extinguishers shall not be installed as the sole protection for flammable liquid hazards of appreciable depth where the surface area exceeds 10 ft2 (0.93 m2).

3-4.2

For flammable liquid hazards of appreciable depth, a Class B fire extinguisher shall be provided on the basis of at least two numerical units of Class B extinguishing potential per ft2 (0.0929 m2) of flammable liquid surface of the largest hazard area. (For fires involving cooking grease or water-soluble flammable liquids, see 2-3.2 and 2-3.4.)

Exception: AFFF- or FFFP-type fire extinguishers shall be permitted to be provided on the basis of 1-B of protection per square foot of hazard.

3-4.3

Two or more fire extinguishers of lower ratings shall not be used in lieu of the fire extinguisher required for the largest hazard area.

Exception: Up to three AFFF- or FFFP-type fire extinguishers shall be permitted to be used to fulfill the requirements, provided the sum of the Class B ratings meets or exceeds the value required for the largest hazard area.

3-4.4

Travel distances for portable fire extinguishers shall not exceed 50 ft (15.25 m). (See Appendix E.)

3-4.4.1

Scattered or widely separated hazards shall be individually protected. A fire extinguisher in the proximity of a hazard shall be carefully located to be accessible in the presence of a fire without undue danger to the operator.

3-5* Fire Extinguisher Size and Placement for Class C Hazards.

Fire extinguishers with Class C ratings shall be required where energized electrical equipment can be encountered that would require a nonconducting extinguishing medium. This requirement includes situations where fire either directly involves or surrounds electrical equipment. Since the fire itself is a Class A or Class B hazard, the fire extinguishers shall be sized and located on the basis of the anticipated Class A or Class B hazard.

3-6 Fire Extinguisher Size and Placement for Class D Hazards.

3-6.1

Fire extinguishers or extinguishing agents with Class D ratings shall be provided for fires involving combustible metals.

3-6.2

Fire extinguishers or extinguishing agents (media) shall be located not more than 75 ft (23 m) of travel distance from the Class D hazard. (See Section E-6.)

3-6.3

Portable fire extinguishers or extinguishing agents (media) for Class D hazards shall be provided in those work areas where combustible metal powders, flakes, shavings, chips, or similarly sized products are generated.

3-6.4

Size determination shall be on the basis of the specific combustible metal, its physical particle size, area to be covered, and recommendations by the fire extinguisher manufacturer on data from control tests conducted.

3-7 Fire Extinguisher Size and Placement for Class K Fires. 3-7.1

Fire extinguishers shall be provided for hazards where there is a potential for fires involving combustible cooking media (vegetable or animal oils and fats).

3-7.2

Maximum travel distance shall not exceed 30 ft (9.15 m) from the hazard to the extinguishers.

Standpipe Fire Systems

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DEPARTMENT OF LABOR & INDUSTRY

29 CFR 1910.158

Scope

This standard applies to all small hose, Class II and Class III Standpipe Systems installed to meet the requirements of a particular OSHA Standard.

Exception.

This section does NOT apply to Class I Standpipe Systems.

Class I Standpipe

- Intended for Fire Department use only.
- 2½ inch angle valve for hose attachment.
- Not provided with hose; Fire department will use its own.

Class I

Class II Standpipe

- Previously intended only for building occupant use.
- Equipped with 1 ½ inch hose in varying lengths (50 to 150 feet).
- Designed to discharge water at 50 GPM per hose rack at 65 PSI pressure.
- NFPA 14 now restricts this type for use by trained industrial fire brigades.

Class III Standpipe

- 2½ inch angle valve for fire department use and 1½ inch hose rack assembly for industrial fire brigade use.
- A 2½ inch hose valve with a 2½ inch to 1½ inch reducer and a 1½ inch cap and chain can be used to satisfy the Class III standpipe requirement.
- Many building codes will require the installation of a Class III standpipe system. This requirement can be met without installing a hose rack assembly.

Protection of Standpipes

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These shall be located or otherwise protected against mechanical damage. Damaged standpipes shall be repaired promptly.

Equipment

- Reels and cabinets are designed to facilitate prompt use.
- They must be conspicuously identified.
- Cabinets are used only for fire equipment.

Outlets and Connections

For Hoses:

- Located above the floor to avoid being obstructed and be accessible.
- Use standardized screw threads or provide adapters.

Hose

Assure every 1½ inch or smaller hose outlet used is equipped with hose connected and ready for use.

In extremely cold climates, hose may be stored in another location provided it is readily available and can be connected when needed.

Hose

Standpipe systems installed after January 1, 1981, for use by employees, shall be equipped with lined hose.

Unlined hose may remain in use on existing systems. However, after the effective date of this standard, unlined hose which becomes unserviceable shall be replaced with lined hose.

Hose

Hose of such length that friction loss resulting from water flowing through the hose will not decrease the pressure at the nozzle below a nozzle pressure of 30 psi. The dynamic pressure at the nozzle shall be within the range of 30 psi to 125 psi.

Nozzles

Assure standpipe hose is equipped with shut-off type nozzles.

No*

Yes

Yes

Water Supply

The minimum water supply for standpipe and hose systems, which are provided for the use of employees, shall be sufficient to provide 100 gallons per minute for a period of at least thirty (30) minutes (3,000 gallons).

Acceptance Tests

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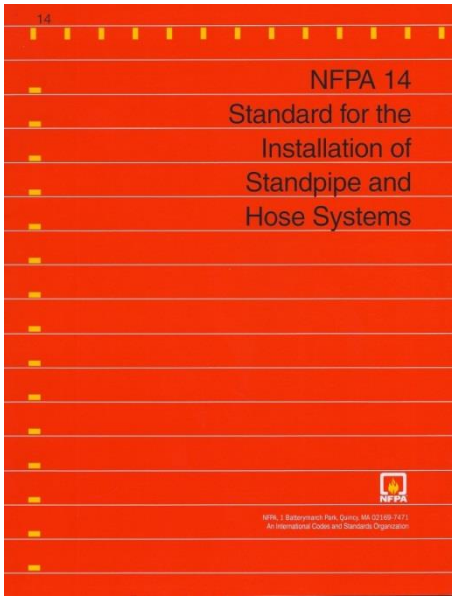
Piping of Class II and Class III systems installed after January 1, 1981, including yard piping, is hydrostatically tested for a period of at least 2 hours at not less than 200 psi,



Or at least 50 psi in excess of normal pressure when such pressure is greater than 150 psi.

Acceptance Tests

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Hose on all standpipe systems installed after January 1, 1981, is hydrostatically tested with couplings in place, at a pressure of not less than 200 psi, before it is placed in service. This pressure shall be maintained for at least 15 seconds and not more than one (1) minute during which time the hose shall not leak nor shall any jacket thread break during the test.