FIRE PROTECTION SYSTEM DESIGNS

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Fire Protection System

Active

Detection

Fire suppression systems

Passive

Structural

Means of Escape

Fire Suppression Systems

The suppression system can be categorized as

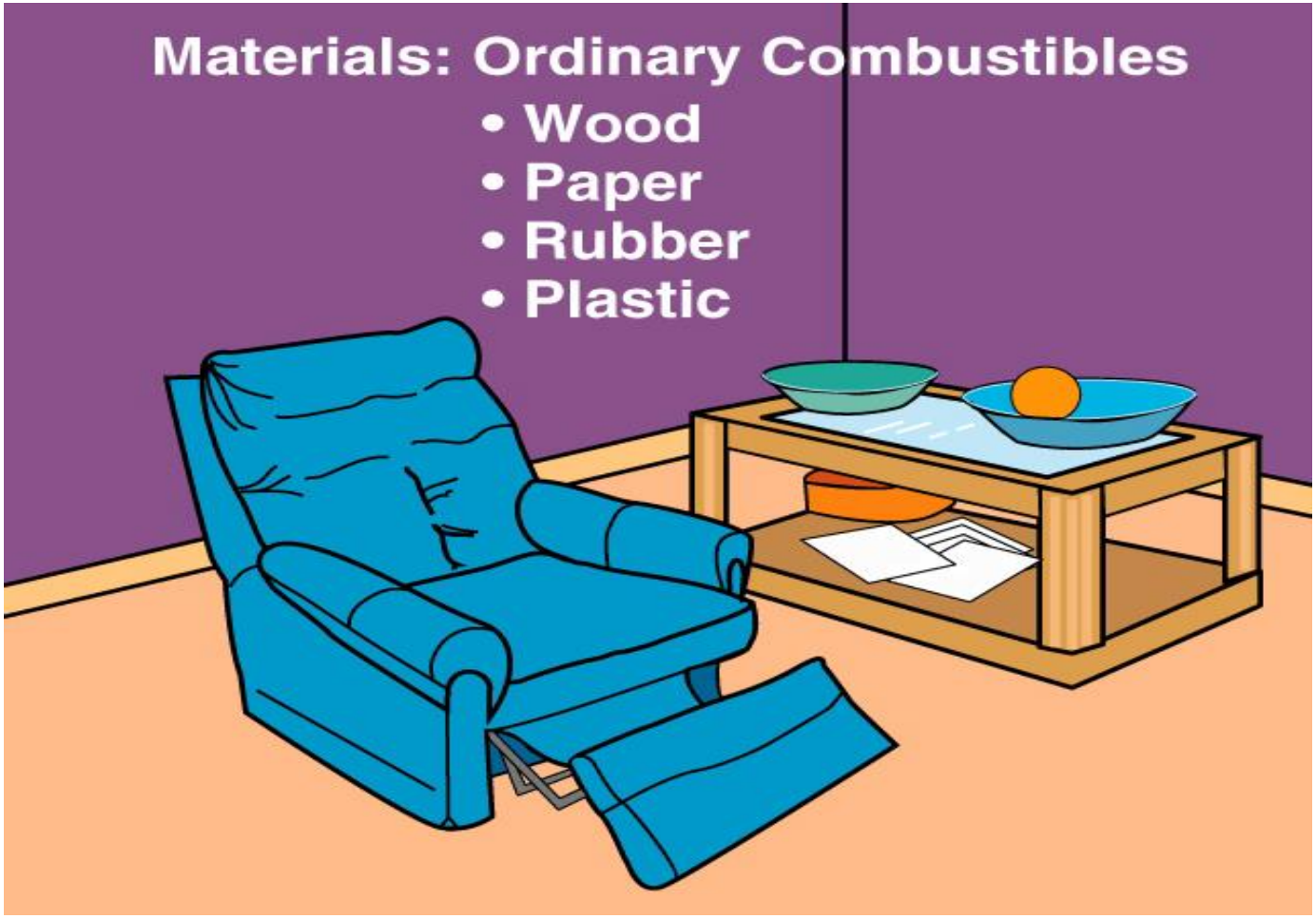
1. Fire Extinguisher
2. Hose Reel system
3. Dry Riser System
4. Wet Riser Systems
5. Sprinkler Systems
6. Gas suppression system
7. Foam systems

Fire Extinguishers

Fire Extinguisher Overview

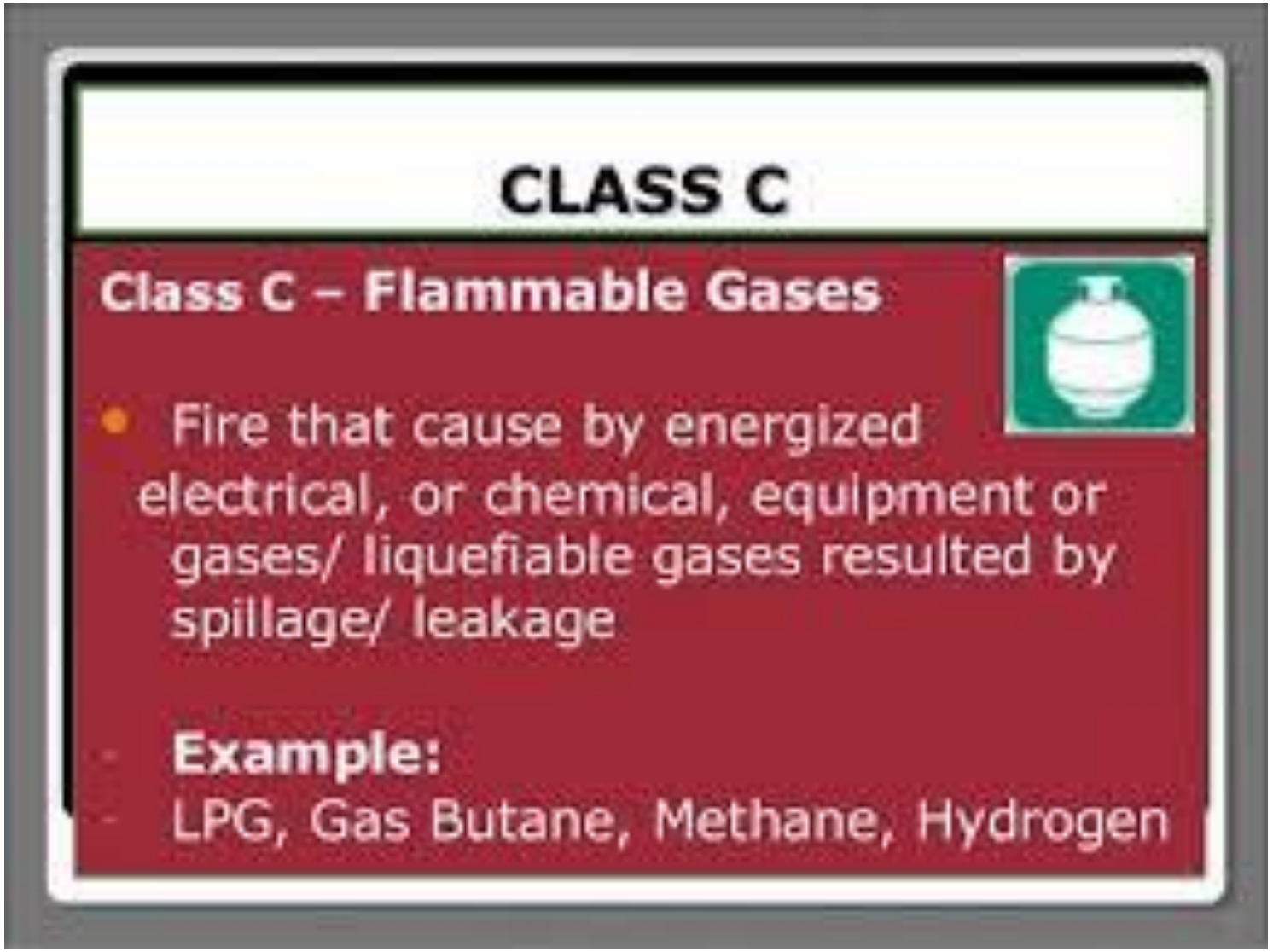
1. Fire Extinguisher Classification & UL Ratings
   - **Class A**
   - **Class B**
   - **Class C**
   - **Class D**
   - **Class E**
   - **Class K**
2. Hazard Classification
   - **Light**
   - **Ordinary**
   - **High**
3. Extinguisher Size & Placement
   - **Hazard / Hazard Area**
   - **Rating & Coverage Area**
   - **Allowable Travel Distance**
4. Maintenance & Inspection
   - **Monthly Inspection**
   - **Annual Maintenance**
   - **6 Year Maintenance**
   - **Hydrostatic Test**

CLASS “A” FIRES - Ordinary combustibles such as wood, paper, cloth.

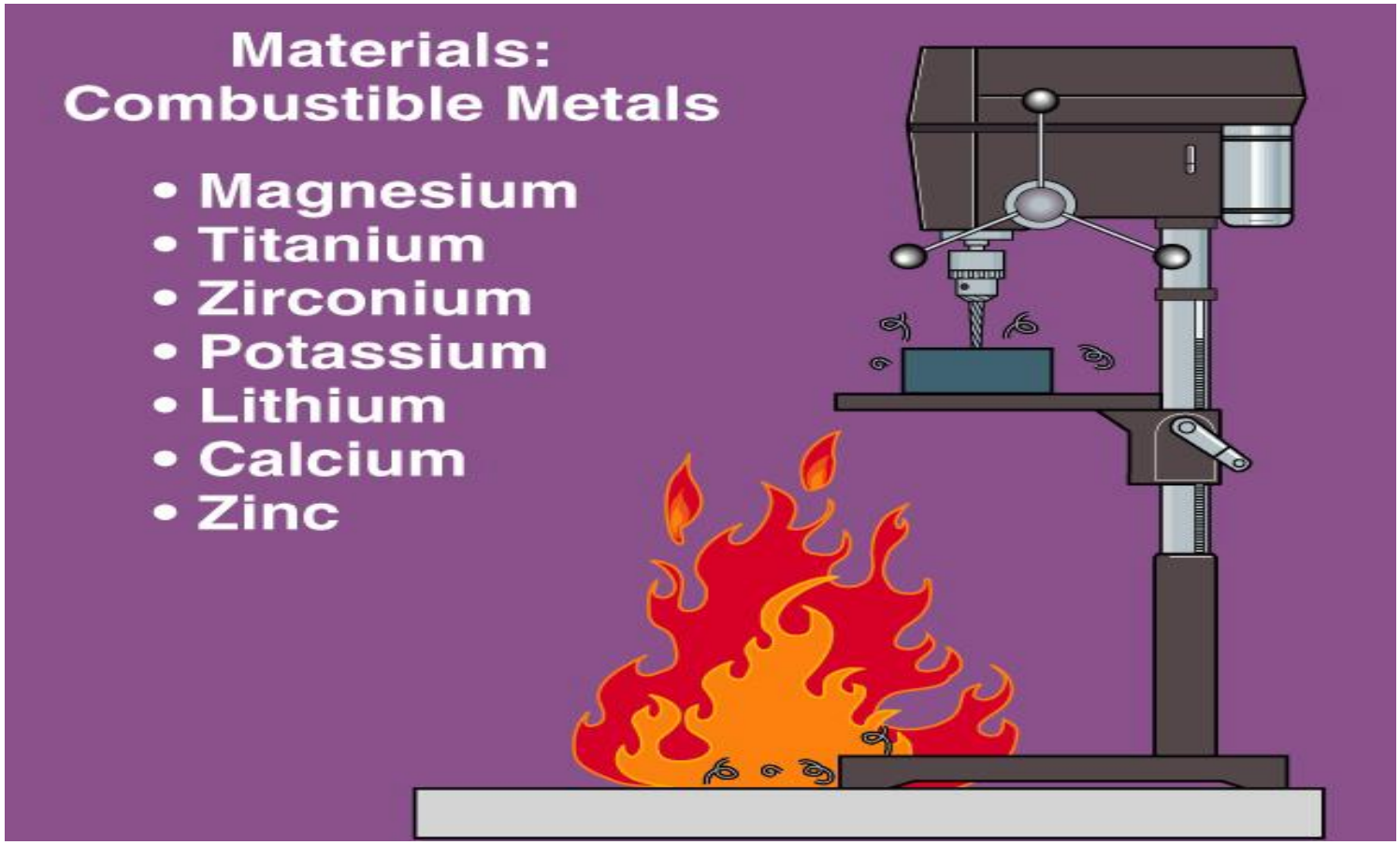


CLASS "B" FIRES - Flammable liquids such as oil, grease

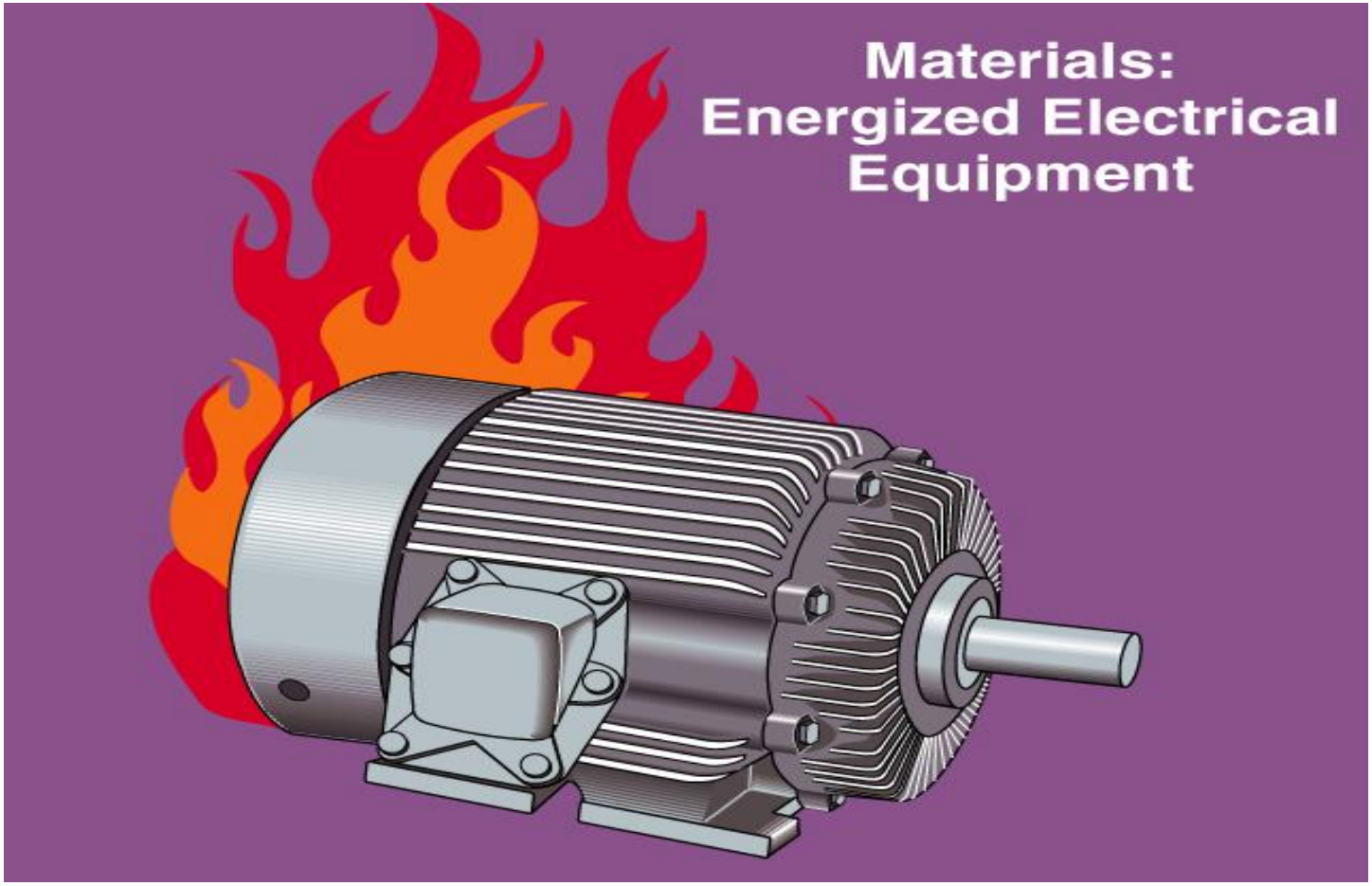
CLASS “C” FIRES - Flammable Gases



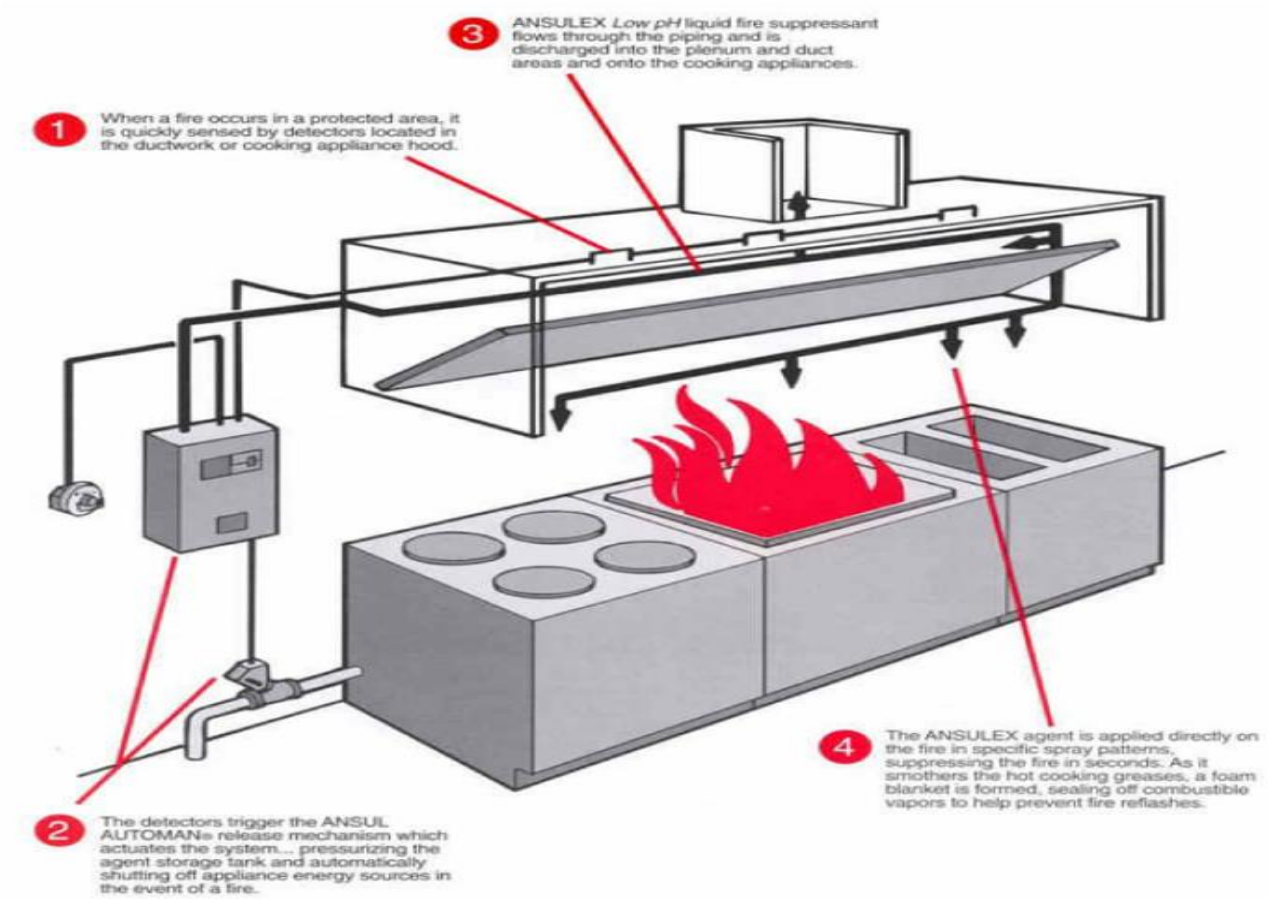
CLASS “D” FIRES - Flammable Metals



CLASS “E” FIRES - Energized electrical equipment



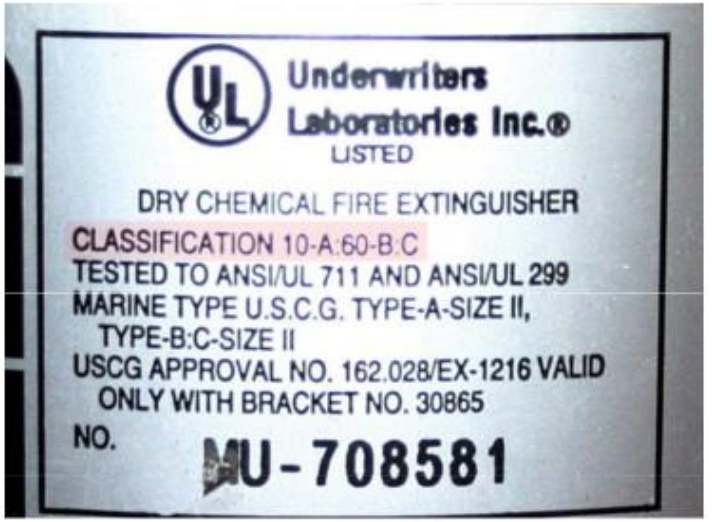
CLASS “K” FIRES - Fires in Cooking Appliances



CLASSES OF FIRES	TYPES OF FIRES	SYMBOL
A	Wood, paper, fabric, plastic, and most kinds of trash.	
B	Flammable **liquids** (for example,gasoline).	
C	Burning **gases** (for example,natural gas).	
D	Combustible **metals*** such as magnesium, potassium, titanium, and zirconium. * Exception of the metals that burn in contact with air or water (for example, sodium).	
E	Fires involving potentially energized **electrical equipment**.	
F	Unsaturated **cooking oils** in well insulated cooking appliances located in commercial kitchens.	

Rating in UL Classification

- The A rating is a water equivalency rating. Each A is equivalent to 1.25 gallons of water. 4A=5 gal. of water.
- The B rating is equivalent to the amount of square footage that related to the degree of training and experience of the operator, the extinguisher can cover.
  20 B =20 sq. ft. of coverage.
- C indicates it is suitable for use on electrically energized equipment.



The UL rating is found on the extinguisher label or nameplate band.

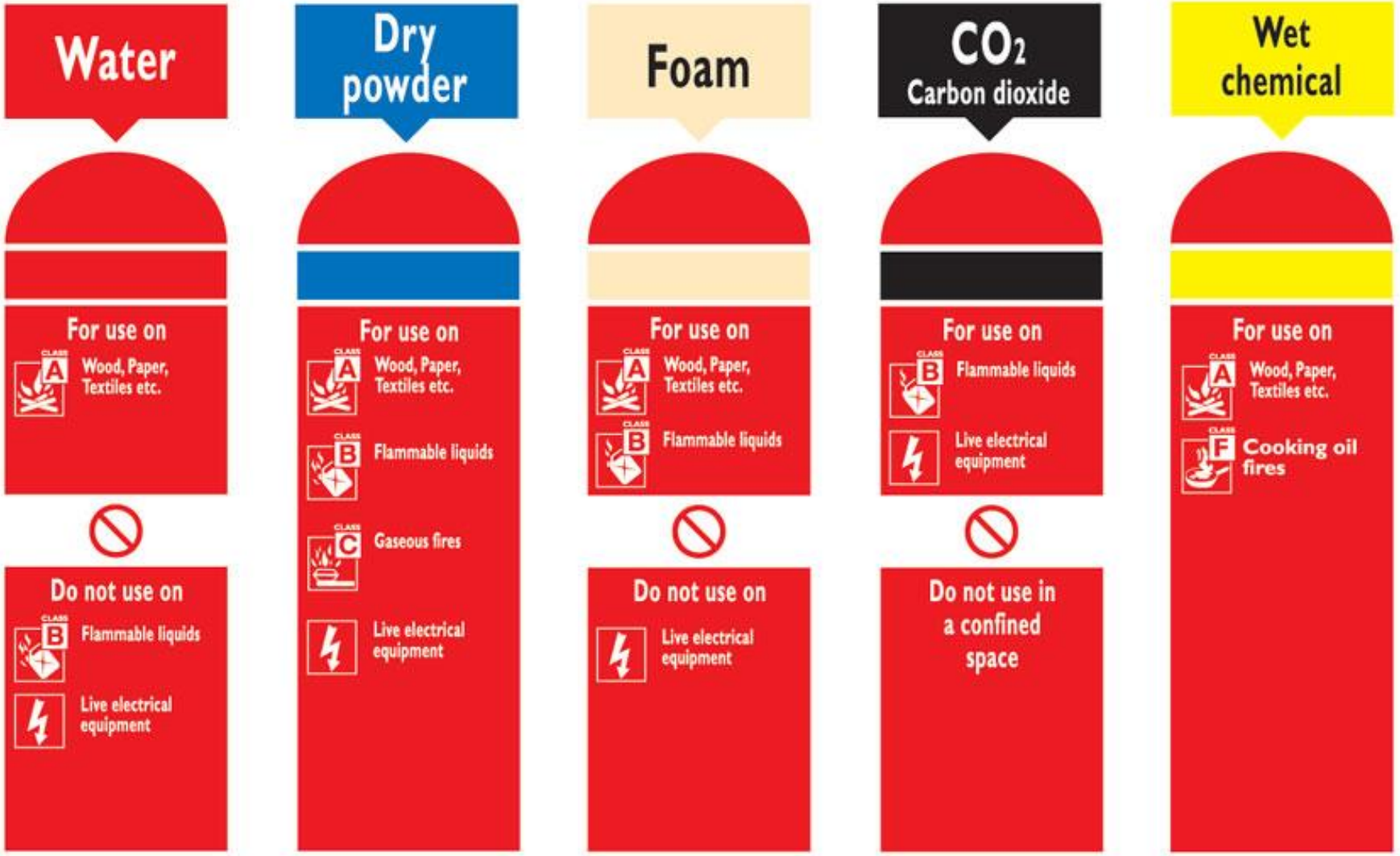
Fire Class Vs Extinguishers Types

Class	Nature	Example	Extinguisher Type
A	Carbonaceous	Wood , paper, textiles	Water
B	Flammable liquids	Adhesives Flammable liquid stores Bitumen boilers, petrol or diesel Powered equipment Cooking range fires	Dry power Dry power or foam Dry power foam carbon dioxide Dry power carbon, dioxide or fire blanket
C	Flammable gases	LPG, acetylene	Carbon dioxide, dry power
D	Reactive metals	Magnesium, sodium etc.	Dry power specially developed for particular metals
E	Electrical	Any material where there is a danger of live electricity	Carbon dioxide, dry power
K	Fires in Cooking Appliances	That involves combustible cooking media (vegetables, animal oil & fats)	Dry power, Foams

Fire Extinguisher Color Code

Type	Old Code	BS EN 3 Colour Code	Fire Class
Water	Signal Red	Signal Red	A
Foam	Cream	Signal Red with a cream panel above the operating Instructions	A B
Dry Powder	French Blue	Red with a Blue panel above the operating instructions	A, B, C
Carbon Dioxide	Black	Red with a Black panel above the operating instructions	A(Limited), B
Wet Chemical	Not in use	Red with a Canary Yellow panel above the operating instructions	A,F
Graphite Powder	French Blue	Red with a Blue panel above the operating instructions	A, D

KNOW YOUR FIRE EXTINGUISHER COLOUR CODE



KNOW YOUR FIRE EXTINGUISHER COLOUR CODES B.S.EN3

Fire Risk	WATER	FOAM	POWDER	CO_2 CARBON DIOXIDE	WET CHEMICAL
A — Use on Wood, Paper or Textile Fires	✓	✓	✓		✓
B — Use on Flammable Liquid Fires		✓	✓	✓	
C — Use on Gaseous Fires			✓		
F — Use on Cooking Oils and Deep Fat Fires					✓
Use on Electrical Fires			✓	✓	

Water Extinguishers

- APW (Air pressurized water) Cool burning material by absorbing heat.
- Effective on Class A fires
- The advantage of being inexpensive, harmless, and relatively easy to clean up.
- The disadvantages of water is, it is harmful to modern electronic office equipment

Carbon Dioxide

- Generally red, have a LARGE "tapered“ nozzle (horn) and are VERY HEAVY (15-85 lbs).
- These are all high- pressure cylinders.
- CO2 cylinders do not have a pressure gauge - they must be weighed to determine the amount of contents.
- Suitable for class B,C & E fires

Dry Chemical

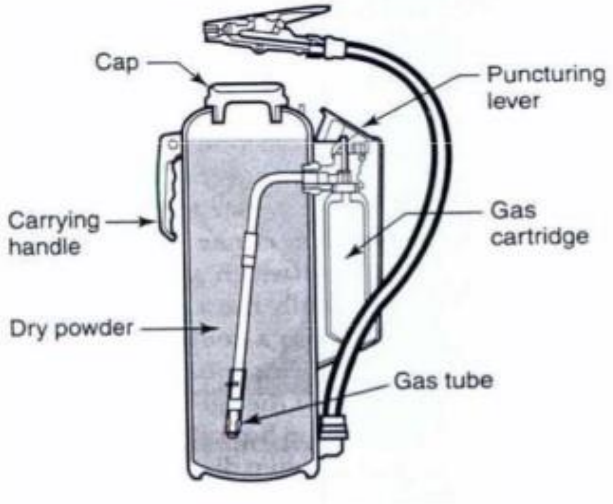
- Sodium bicarbonate, "regular" or "ordinary" used on class **B** and **C** fires, was the first of the dry chemical agents developed.
- It interrupts the fire's chemical reaction, and was very common in commercial kitchens before the advent of wet chemical agents.

Dry Chemical Cartridge Units

Cartridge extinguishers differ from “stored” pressure units by utilizing a gas cartridge to pressurize the extinguisher. The unit can be exposed to an impact or puncture without discharging the contents.

Discharge hose and nozzle must be completely free of agent after use.

Classes: ABCD



ABC Dry Chemical

ABC-rated multipurpose dry powder extinguishers are the most common. They are almost always RED in color and have either a long narrow hose or no hose (*just a short nozzle*).

Class D Extinguisher

- There are several Class D fire extinguisher agents available, some will handle multiple types of metals, others will not.

- Sodium Chloride
  - contains sodium chloride salt and thermoplastic additive.
  - Plastic melts to form an oxygen-excluding crust over the metal, and the salt dissipates heat.
  - Useful on metals including sodium,potassium, and other metals including magnesium, titanium, aluminum, and zirconium.

- Most Class D extinguishers will have a special low velocity nozzle or discharge wand to gently apply the agent in large volumes to avoid disrupting any finely divided burning materials

Class K Extinguisher

- Class K fire extinguishers are wet chemical extinguishers that contain a potassium acetate based, low PH agent that was originally developed for use in pre-engineered cooking equipment fire extinguishing systems.
- The Class K extinguishers are tested on commercial deep fat fryers using the same type of fire test as UL300 pre-engineered restaurant fire extinguishing systems. The agent discharges as a fine mist which helps prevent grease splash and fire reflash while cooling the appliance.

- When hazard areas include deep fat fryers, listed Class K portable fire extinguishers shall be provided as follows:
- For up to four fryers having a maximum cooking medium capacity of 80 pounds (36.3 kg) each: One Class K portable fire extinguisher of a minimum 1.5 gallon (6 L) capacity

.

Water Mist

- Water Mist uses a fine misting nozzle to break up a stream of deionized water to the point of not conducting electricity back to the operator.
  - Class A and C rated.
  - It is used widely in hospitals for the reason that, unlike other clean-agent suppressants, it is harmless and non-contaminant.
  - These extinguishers come in 1.75 and 2.5 gallon units, painted white.

Halon & Replacement Agents

- Halon (including Halon 1211 and Halon 1301),a gaseous agent that inhibits the chemical reaction of the fire.
- Banned from January 1, 1994 as its properties contribute to ozone depletion and long atmospheric lifetime, usually 400 years.
- Currently Halotron I, Halotron II, FE-36 Cleanguard and FM-200 are meant to be replacements with significantly reduced ozone depletion potential.

Foam Extinguishers

- Two types :- Synthetic & Protein
- Suitable for class A & B

Synthetic foams : Definitions

Synthetic foams are based on synthetic surfactants. Synthetic foams provide better flow, faster knockdown of flames, but limited post-fire security.

Aqueous film forming foams (**AFFF**) are water-based and frequently contain hydrocarbon-based surfactant such as sodium alkyl sulfate, and fluorsurfactant—such as fluorotelomers, perfluorooctanoic acid (PFOA), or perfluorooctanesulfonic acid (PFOS). They have the ability to spread over the surface of hydrocarbon-based liquids. **Alcohol-resistant aqueous film forming foams** (**AR-AFFF**) are foams resistant to the action of alcohols, able to form a protective film when they are present.

Protein foams: Definitions

Protein foams (FFFP) contain natural proteins as the foaming agents.

Unlike other synthetic foams, protein foams are bio-degradable. They flow and spread slower, but provide a foam blanket that is more heat resistant and more durable.

Protein foams include **regular protein foam** (**P**), **fluoroprotein foam** (**FP**), **alcohol resistant fluoroprotein foam** (**AR-FP**), **film forming fluoroprotein** (**FFFP**), and **alcohol-resistant film forming fluoroprotein** (**AR-FFFP**).

Size & Placement

There are four topics to review when installing portable fire extinguishers.

- Identify the hazards that are present.
- Determine the size of the fire extinguisher.
- Establish the quantity by the coverage that is allowed by the adopted NFPA 10 standard.
- Distribute the portable fire extinguishers per the allowable travel distance to each fire extinguisher.

Classification of Hazards NFPA 10: 1.4

- ***Light (Low) Hazard***. Light hazard occupancies are locations where the total amount of Class A combustible materials including furnishings decorations and contents is of minor quantity. This can include some buildings or rooms occupied as offices classrooms churches assembly halls guest room areas of hotels/motels and so forth. This classification anticipates that the majority of content items are either noncombustible or so arranged that a fire is not likely to spread rapidly Small amount of Class B flammables used for duplicating machines art departments and so forth are included provided that they are kept in closed containers and safely stored.

- ***Ordinary (Moderate) Hazard***. Ordinary hazard occupancies are locations where the total amount of Class A combustibles and Class B flammables are present in greater amounts than expected under light low hazard occupancies. These occupancies could consist of dining areas mercantile shops and allied storage light manufacturing research operations auto showrooms parking garages.

- ***Extra (High) Hazard***. Extra hazard occupancies are locations where the total amount of Class A combustibles and Class B flammables present in storage production use finished product or combination thereof is over and above those expected in occupancies classed as ordinary (moderate) hazard. These occupancies could consist of; woodworking; vehicle repair; aircraft and boat servicing; cooking areas; individual product display showrooms; product convention center displays; and storage and manufacturing processes such as painting, dipping and coating, including flammable liquid handling. Also included is warehousing of or in-process storage of other than Class I and Class II commodities.

Size & Placement

Class A Fire Hazard – Minimum Size of Fire Extinguisher

Minimum Extinguisher Rating	Maximum Traveling Distance to Extinguishers	Area to be protected per Extinguisher		
		Low Hazard Occupancy	Ordinary Hazard Occupancy	High Hazard Occupancy
3A	30m	30 sqm	15 sqm	8 sqm
5A	30m	50 sqm	25 sqm	15 sqm
8A	30m	80 sqm	40 sqm	20 sqm
13A	30m	130 sqm	65 sqm	35 sqm
21A	30m	210 sqm	105 sqm	55 sqm
27A	30m	270 sqm	135 sqm	70 sqm
34A	30m	340 sqm	170 sqm	85 sqm
43A	30m	430 sqm	215 sqm	110 sqm
55A	30m	550 sqm	275 sqm	140 sqm

Size & Placement

Class B Locations – Minimum Size of Fire Extinguisher

Type of Hazard	Basic Minimum Extinguisher Rating	Maximum Travel Distance to Extinguisher
Light	34B 144B	15m 25m
Ordinary	144B 183B	10m 15m
High	183B 233B	7m 10m

Size & Placement

Class C Locations

- Class C extinguishers are required where energized electrical equipment is potentially directly involved or surrounds electrical equipment. The extinguisher shall be sized per the Class A or B hazard.

Class D Locations

- Fire extinguishers for Class D locations shall not be located more than 75 ft. from the hazard. Size determination for Class D locations is based on the specific combustible metal, particle size, area to be covered, and manufacturer recommendations.

Class K Locations

- Class K hazards shall have a fire extinguisher located where there is a potential for a fire involving combustible cooking media (vegetable or animal oils and fats). The extinguisher shall be located no more than 30 ft. from the hazard.

Travel Distance for “A” Rating

NFPA 10 edition 2002 Appendix

Example:

Ex. This placement along outside walls would not be acceptable because the travel distance is clearly violated.

In Figure E.3.6 relocation or additional fire extinguishers or both are needed. The shaded areas indicate voids that are further than 75 ft (227 m) to the nearest extinguisher. The dots represent extinguishers

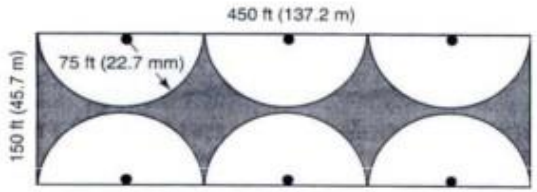


FIGURE E.3.6
A Diagrammatic Representation of Extinguishers Located along the Outside Walls of a 450 ft x 150 ft (137 m x 46 m) Building.

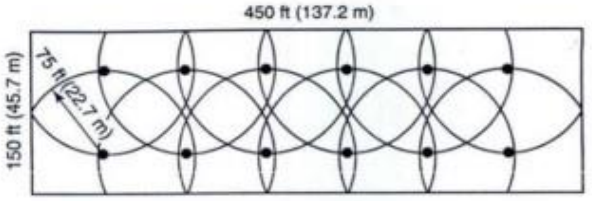


FIGURE E.3.8
Configuration Representing 12 Fire Extinguishers mounted on building columns or interior walls in which requirements for both travel distance and fire extinguisher distribution are met.

Rating of Extinguisher Examples

- For factories, offices, shops, and railway Premises (BS 5306-part 3)
  - 9L water 13A
  - 9L form 34B
  - 2kg CO_2 21B
  - 4 ½ CO_2 34B
  - 3kg Dry Powder 55B
  - 9kg Dry Powder 144B
  - 14kg Dry powder 233B
- More examples given in BS5036- Part 3 for reference

Maintenance & Inspection

There are four inspection/test intervals required.

- **Monthly Inspection** *NFPA 10: 6.2.1*
- **Annual Maintenance** *NFPA 10: 6.3.1*
- **6 year Internal Inspection** *NFPA 10: 6.3.3*
- **Hydrostatic Test** *NFPA 10: 7.1*

HOSE REEL SYSTEM

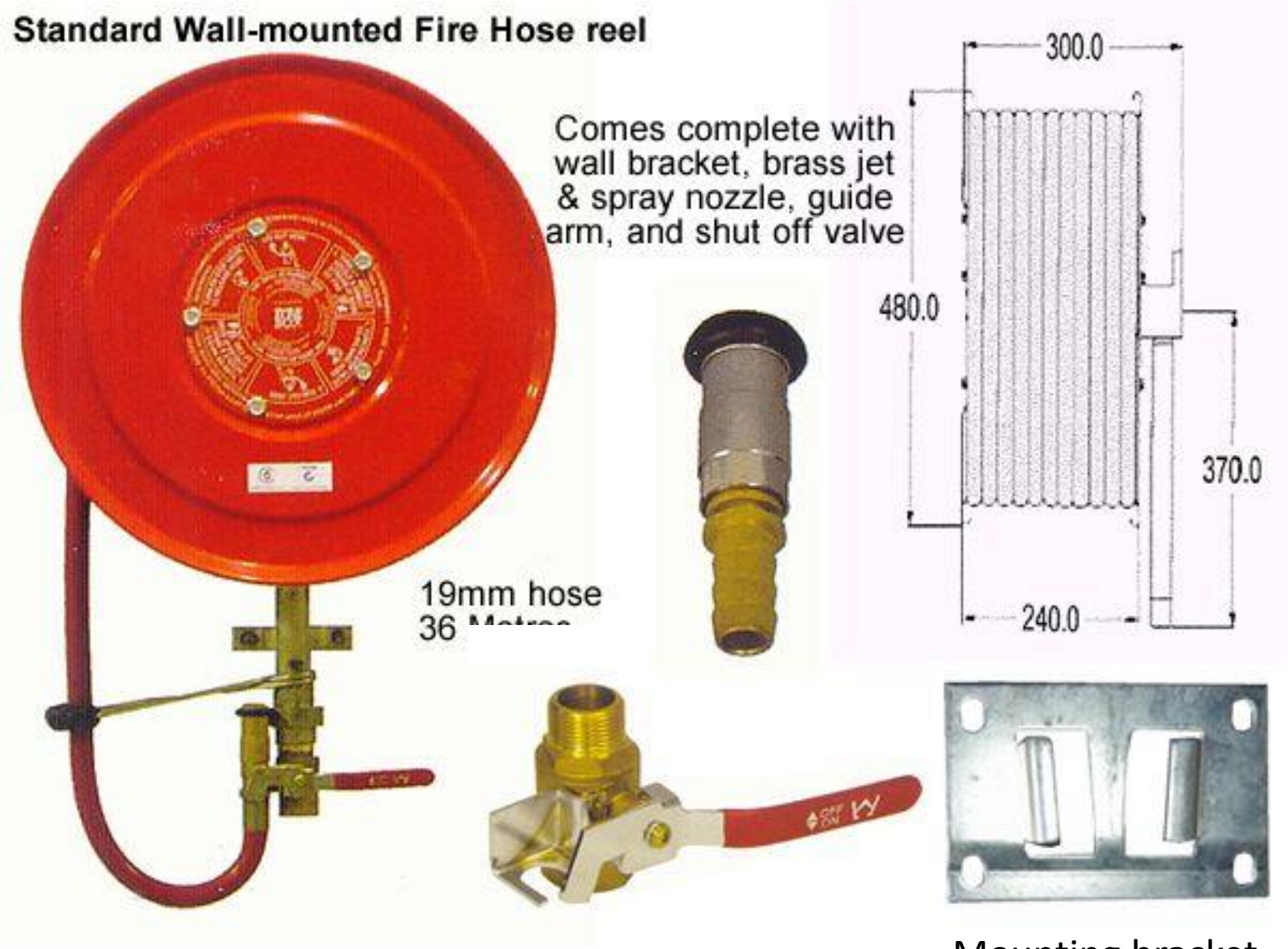
Hose Reel System Assemblies

- Fire hose reel assemblies shall be provided with complete operational instructions for display **on or adjacent** to the hose reel.
- Hose reels shall be marked with the following information;
  - Suppliers name or trademark, or both
  - Year of manufacture
  - Maximum working pressure
  - Length and bore of hose
  - Nozzle diameter (marked on the nozzle)
- Each hose shall be of
  - 19mm diameter(30/45m long hose) or
  - 25mm diameter(30m long hose)
  - non-kinking reinforced rubber hose and terminating with shut-off nozzle
- Nozzles shall be made of HDPE or Brass

Hose Reel System Assemblies

- The pressure at nozzle shall be such that
  - there should be throw of 6m at the rate of 30 l/minute
- Each hose reel connection from riser shall be provided with a ball valve
- Hose reels with semi-rigid hose shall generally comply with BS EN 671-1
- The hose shall terminate in a nozzle which shall give the following control settings;
  - Shut
  - Spray and/or jet.

Hose Reel System Assemblies



Mounting bracket

DESING CONSIDARATION

- A building of purpose group 1 which not exceed 4 story (maximum height 18m)
- A shop/ small offices any other building more than 300sqm
- Every 800 sqm a HR in other buildings
- Mount 900mm above floor level
- Design floor rate 30 l/min (0.5 l/s) per HR
- Should consider 2 HR operate simultaneously (BS 5306)
- Diameter of the supply pipe not less than 50mm,

  if $h \leq 15m$ dim= 50mm

  if $h \geq 15m$ dim= 65mm
- Working pressure
  - 3 bar for 4.8mm nozzle
  - 1.25 bar for 6.35mm nozzle

DRY RISER SYSTEM

DRY RISER SYSTEM

- A water main, normally empty installed in the building
- Install where the conditions are such that a wet system or alternative method cannot be used
  - Cold stores (0^0C)
  - Dry ovens (over 70^0C)
- Normally not practicing SL now
- Used in winter seasons in other countries

Wet Riser System

Wet Riser system

- Wet Riser system
  - Landing Valves
  - Breeching Inlet
  - Hose & Nozzles
  - Design Consideration
  - Pipe Network

Wet Riser landing Valve

- Valve body Shall be of bronze construction
- Shall comprise with
  - 65mm diameter flanged/ threaded inlet and
  - 65mm female outlet
  - with BS instantaneous coupling and cap.
- Inlet pressure exceeding 5 bar shall be pressure reducing type with either
  - a self pressure regulator or
  - a PRV with drain outlet. (Drain should be connected to the sump unless otherwise show in project specification)
- Water pressure at landing valve shall be in excess of 4 bars at any level.
- Landing valve shall be installed in the enclosure or custom made cabinets

Landing Valve *continued ……*

Landing Valve with Pressure regulator

Landing Valve

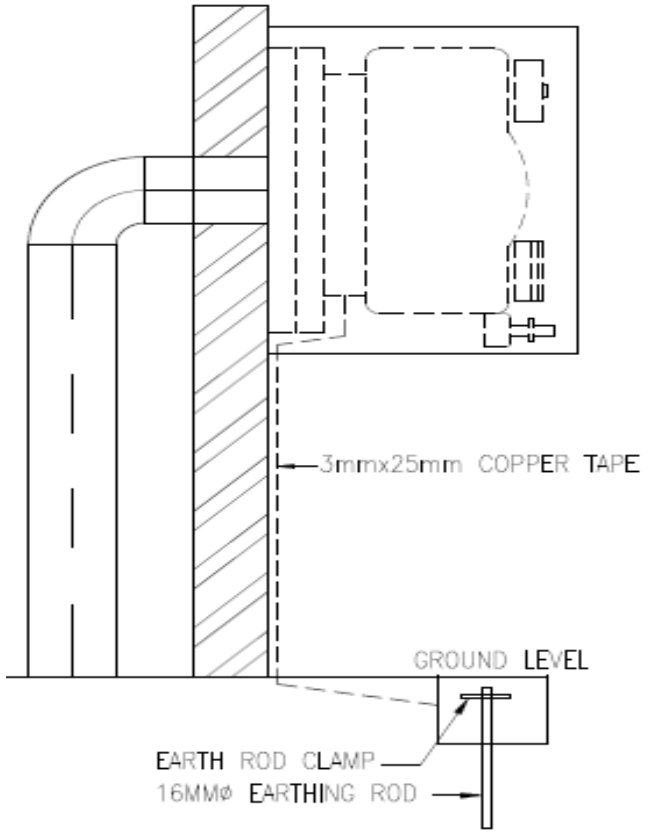
A cabinet with LV & Hoses

Breeching Inlet

- Body shall be of bronze or cast iron construction with 100/150mm diameter flanged outlet
- Shall be 65mm diameter inlets with
  - instantaneous male couplings
  - integral spring loaded non return valve
  - 25mm drain valve with a cap and chain,
  - all in compliance with BSEN.
- Shall be two inlets minimum
- Enclosure shall be constructed form 1.5 mm thick galvanized sheet steel.
- Shall be mounted at 900mm above finish floor level.
- The valve enclosure shall be provided with
  - a hinged lockable door, with a central panel with glazed wired glass
  - labelled “BREECHING INLET” in 100 mm height letters.

Breeching Inlet *continued …*

- Special application
  - Breeching inlet shall be earth using copper tape with inspection pit where open area pipe ring mains



Breeching Inlet *continued …*

2-way
Breeching Inlet

4-way
Breeching Inlet

Fire Hose and Nozzle

- For each Landing valve
  - 65mm diameter, 2x15m long fire hose
  - with instantaneous coupling on one end
  - an adjustable nozzle with isolation valve on the other end
- Fire hose shall be lined with coated woven synthetic material comply to BSEN
- Nozzle shall be of
  - chromium plated bonze and
  - adjustable with shut-off valve and
  - With instantaneous coupling.

Fire Hose and Nozzle *continued…*

15 m long hose with coupling

DIFFUSER NOZZLE 500 (JET/SPRAY)

Code No.	Type	Material	Finishing	Inlet Size	Flowrate @ 65Psi (4.4 Bar)	Throwrange @ 65Psi (4.4 Bar)
WRS099-LA-STD-NA	Standard	Aluminium Alloy to BS 1490	Natural	Male Instantaneous BS 336	500L/min (JET) 590L/min (SPRAY)	26m (JET) 15m (SPRAY)
WRS101-LA-STD-NA	With branchpipe					
WRS099-GM-STD-NA	Standard	Copper Alloy to BS 1400				
WRS101-GM-STD-NA	With branchpipe					
WRS106-GM-52C-NA	Storz inlet			Storz DIN 52C		

Design Consideration

- Used floor level is higher than 18m and above
- Area coverage 900m^2 per riser
- If floor area over 900m^2, should provided two in 60m apart
- Riser main pipe sizes
  - 100mm dia if each level has one LV
  - 150mm dia if each level has two LV & higher that 45 m
- Landing valve should be installed 750mm above floor level
- Each landing valve flow rate 500 l/min (8 l/s)
- Pressure limitation- maximums pressure per system is 24 bar

Design Consideration

- Consider 3 LV simultaneous operation (BS 5306)
- Water Pressure at nozzle is 4bar (400KPa)
- Maximum height is 60m, when h≥ 60m need additional boosting required
- Riser Diameters

  Building Height h ≤ 45m dim = 100mm

  Building Height h ≥ 45m dim = 150mm
- Storage capacity $=3 \times 8 \times 60 \times 45\text{min}/1000$
  $\approx 65\text{m}^3$
  - (the time 45min depends on fire department traveling distance)
- Pump shall be capable to provide 25 liter/s (1500 liters/min)

Number of riser mains (900m2 per raiser)

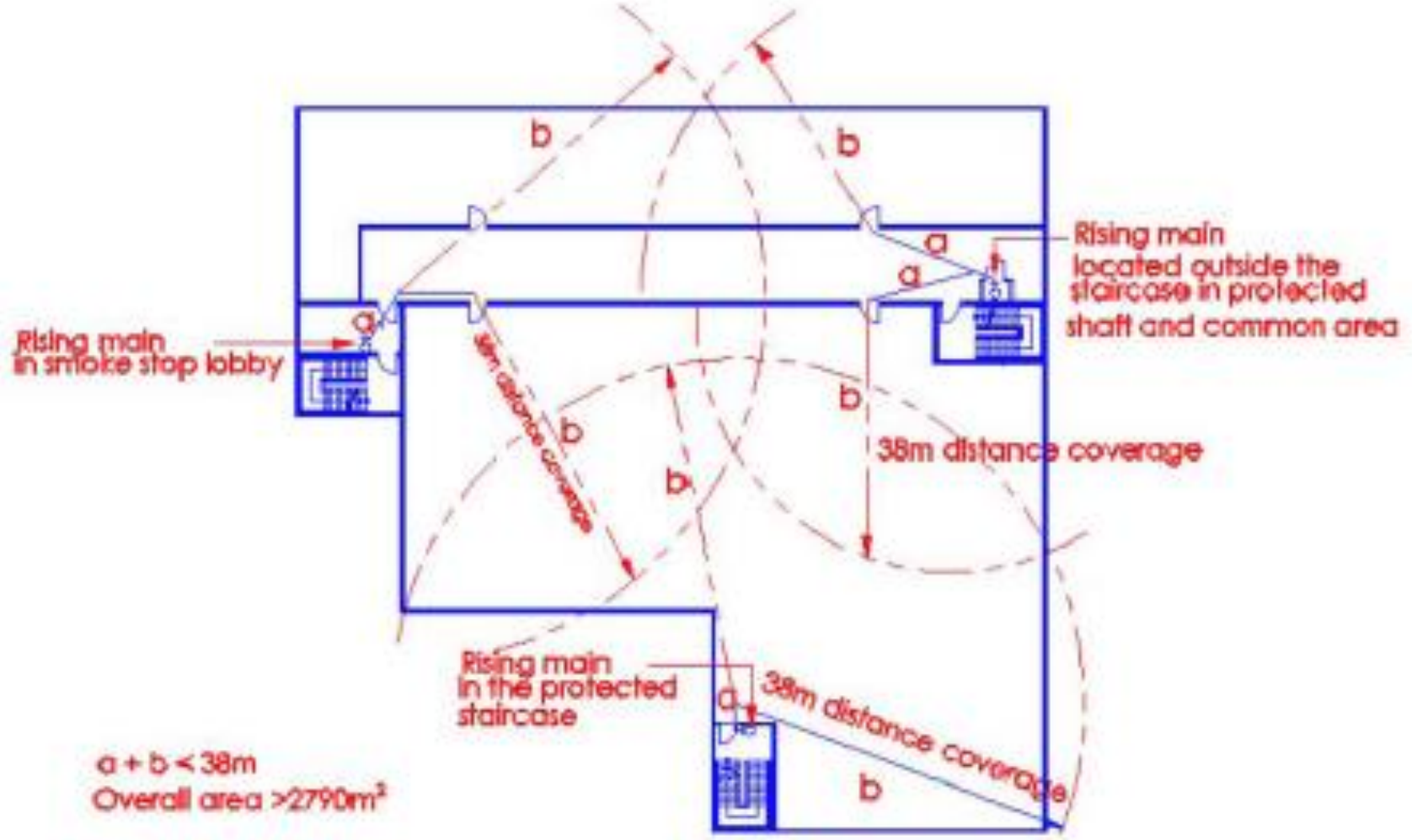
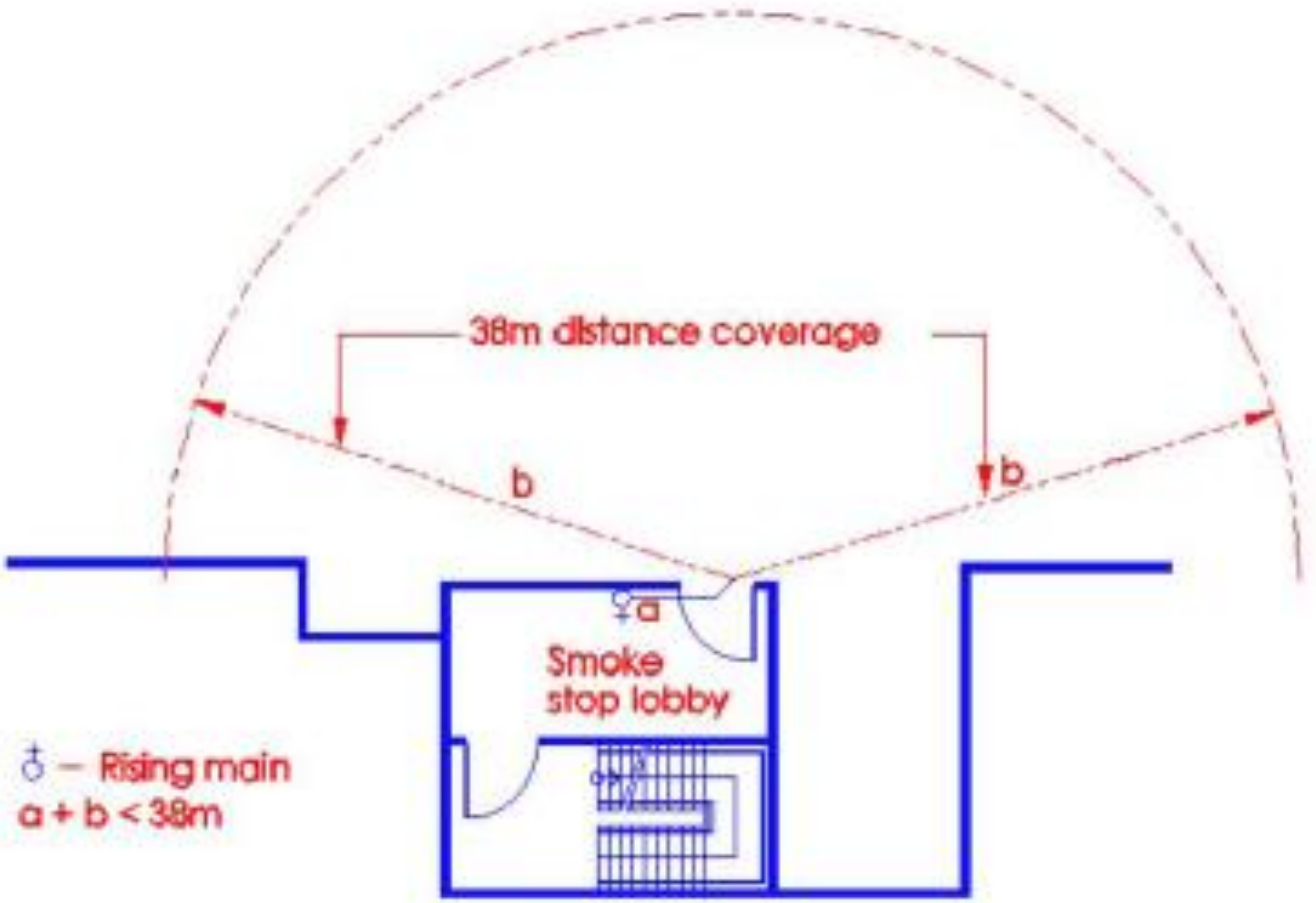


Diagram 6.2.2(a) - 1

Number of riser mains

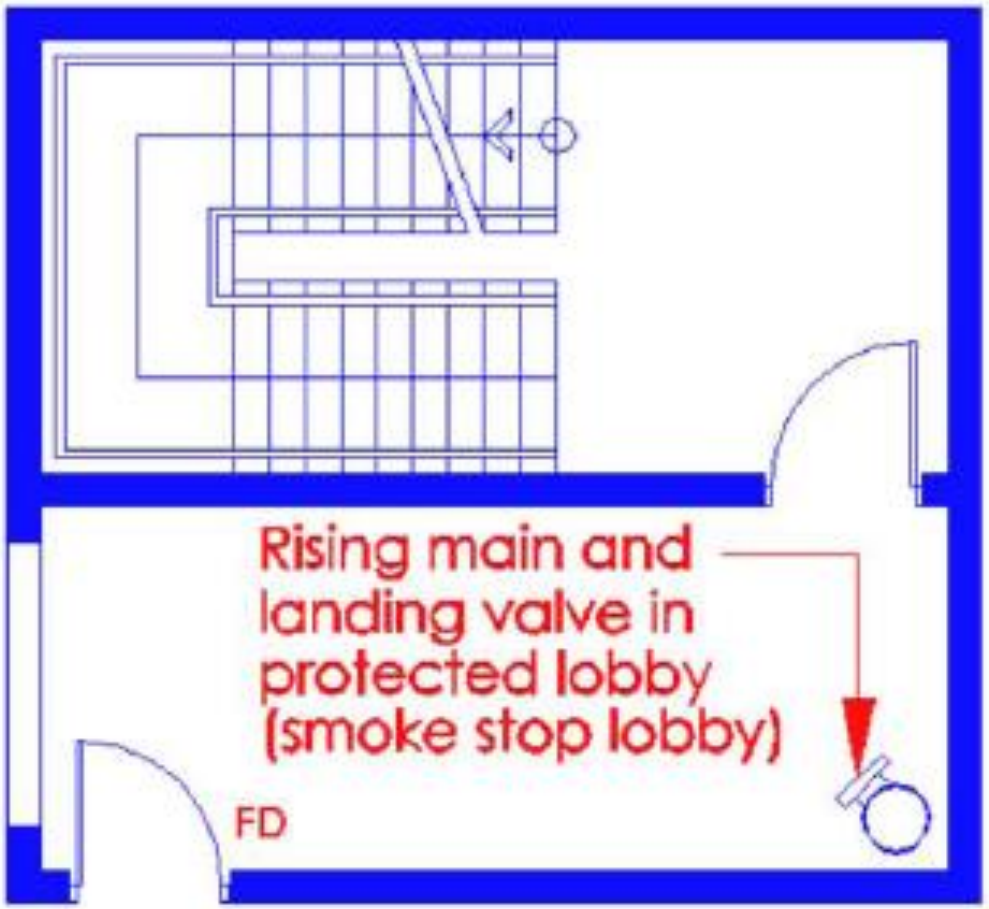


Position of Riser Main

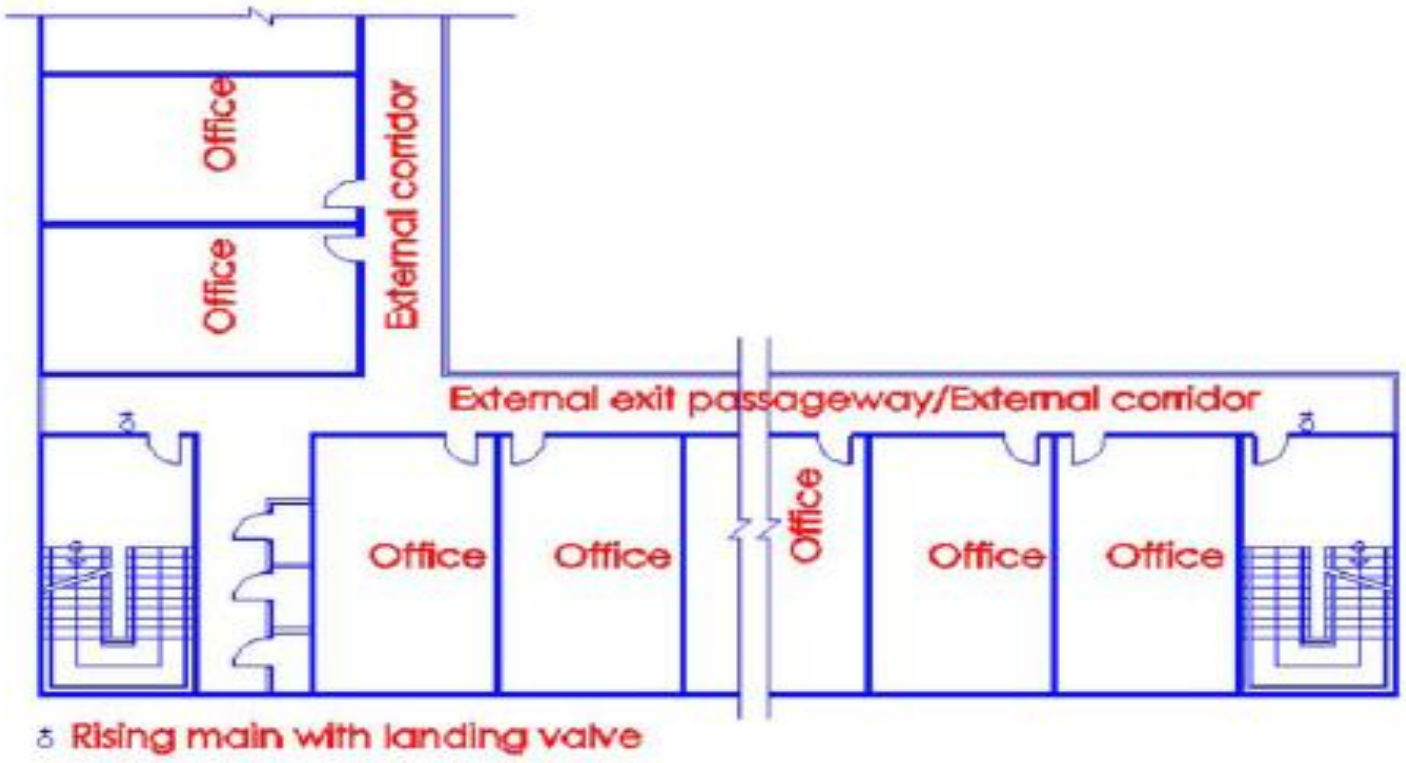
- Riser mains and associate landing valve shall be located in the following order of priority
  - Within smoke- stop lobby
  - In the common area and a protected shaft, immediately outside the exit staircase if there is no smoke free lobby
  - Inside exit staircase where smoke-stop lobby and common area are not provided
- Located where protected against mechanical and fire damage
- Apart from gas, steam or fuel pipe lines or electrical cables shaft

Position of Riser Main continued..

(i) **Rising main in protected lobby**

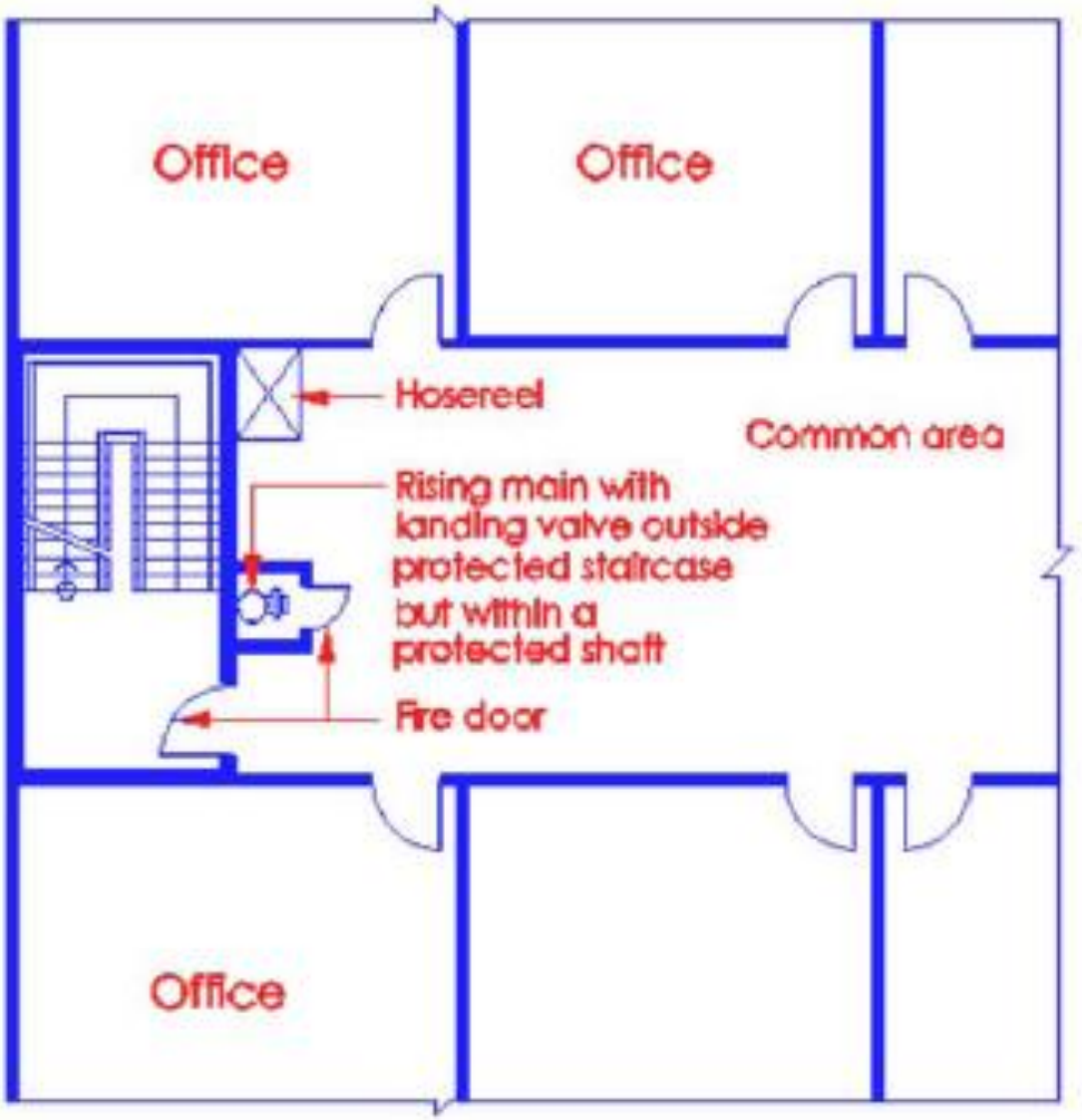


Rising main with natural ventilated staircase



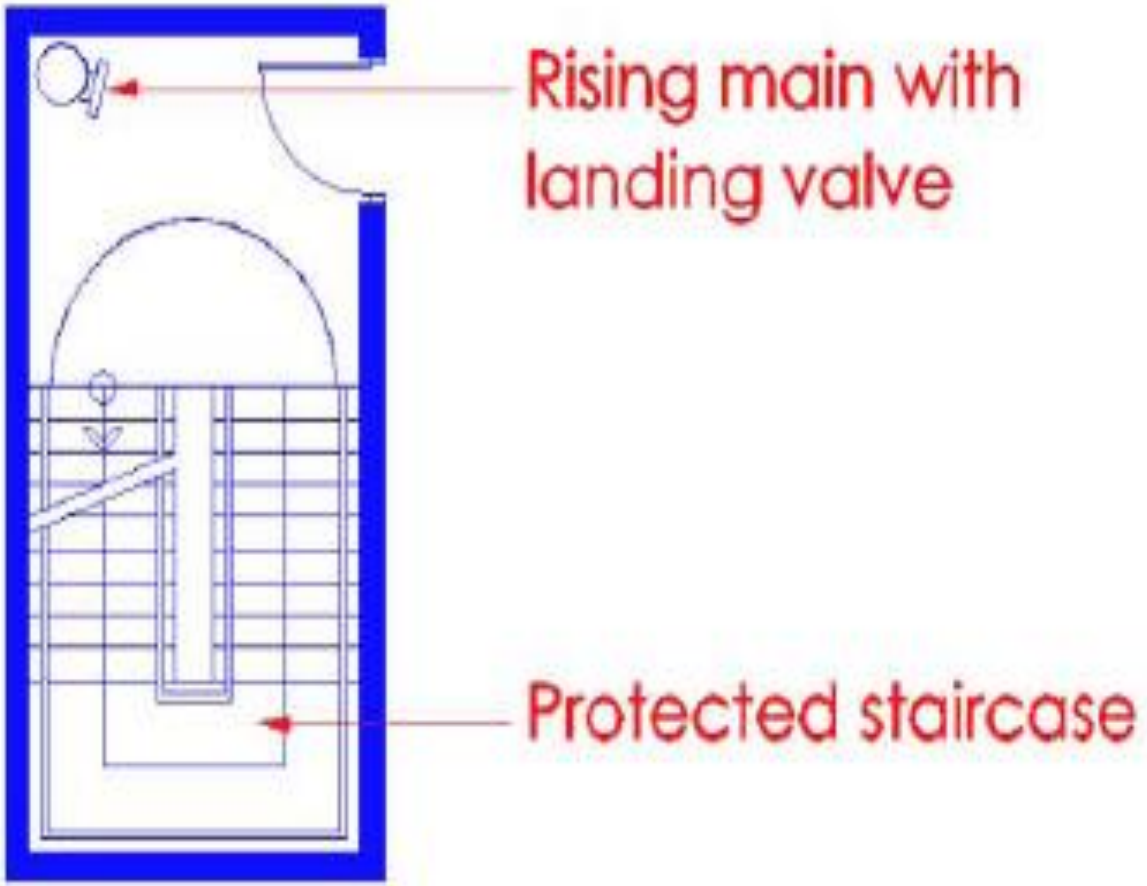
Position of Riser Main continued..

(ii) **Rising main outside protected staircase**



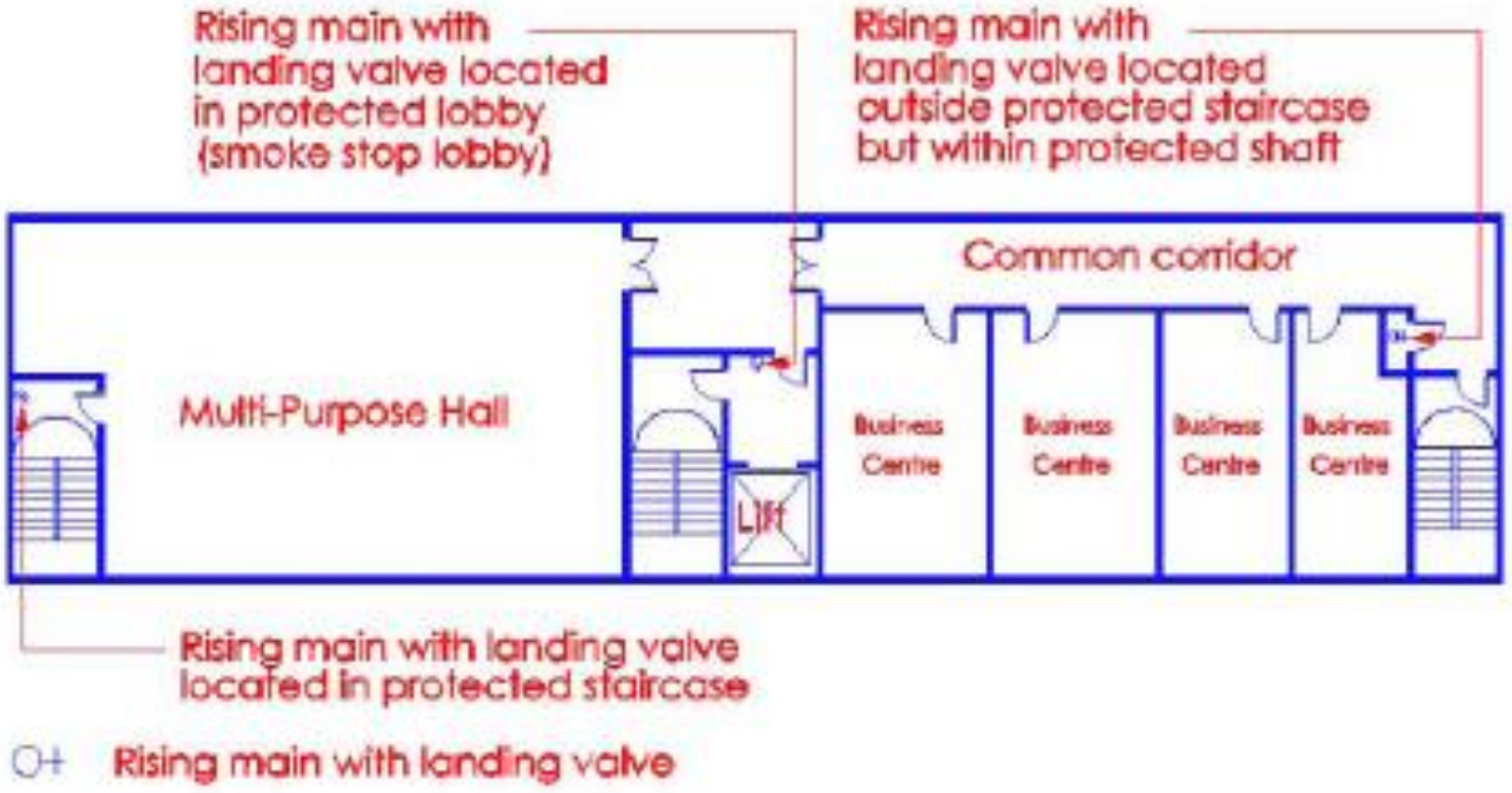
Position of Riser Main continued..

(iii) **Rising main inside protected staircase**

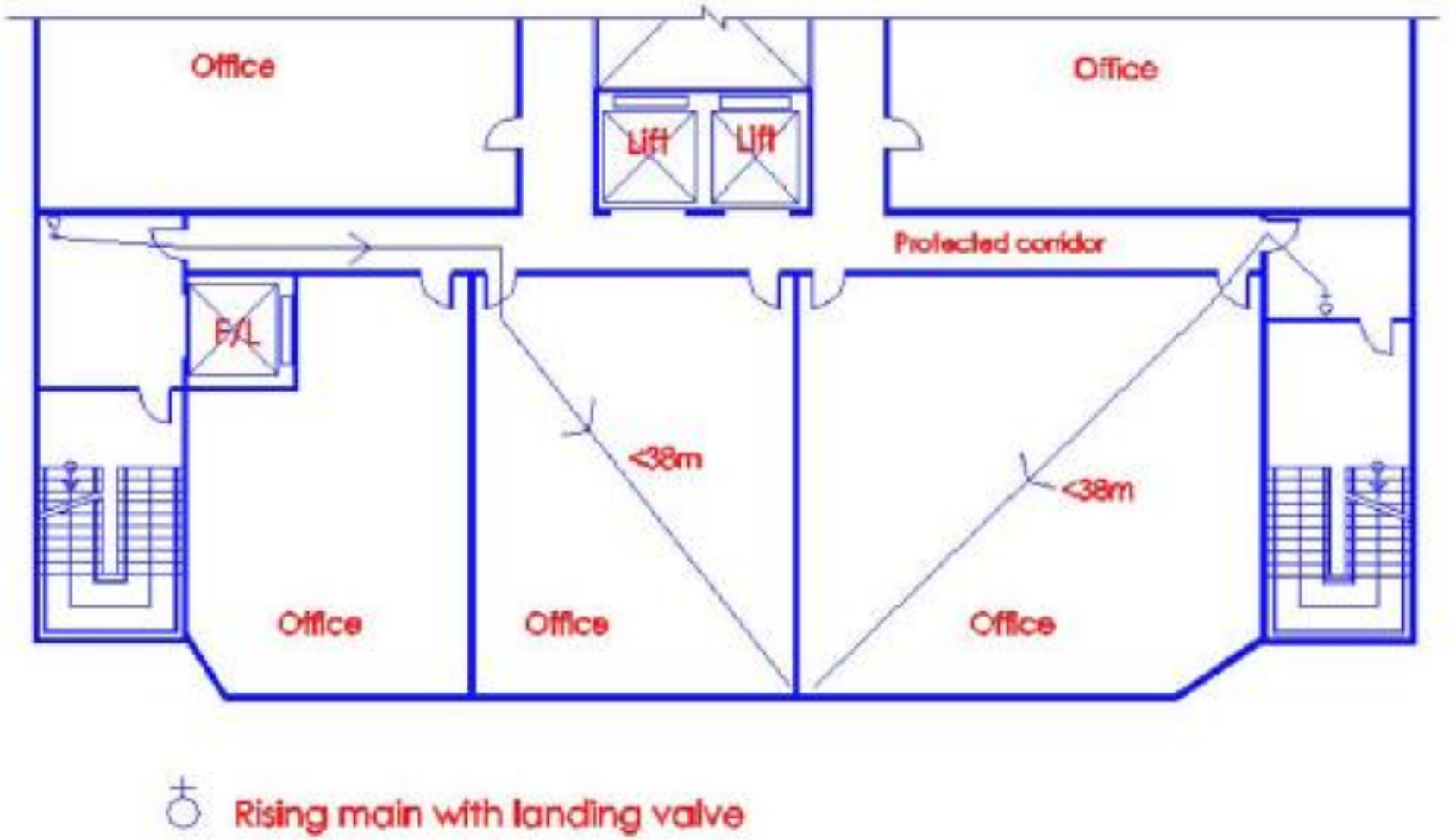


Position of Riser Main continued..

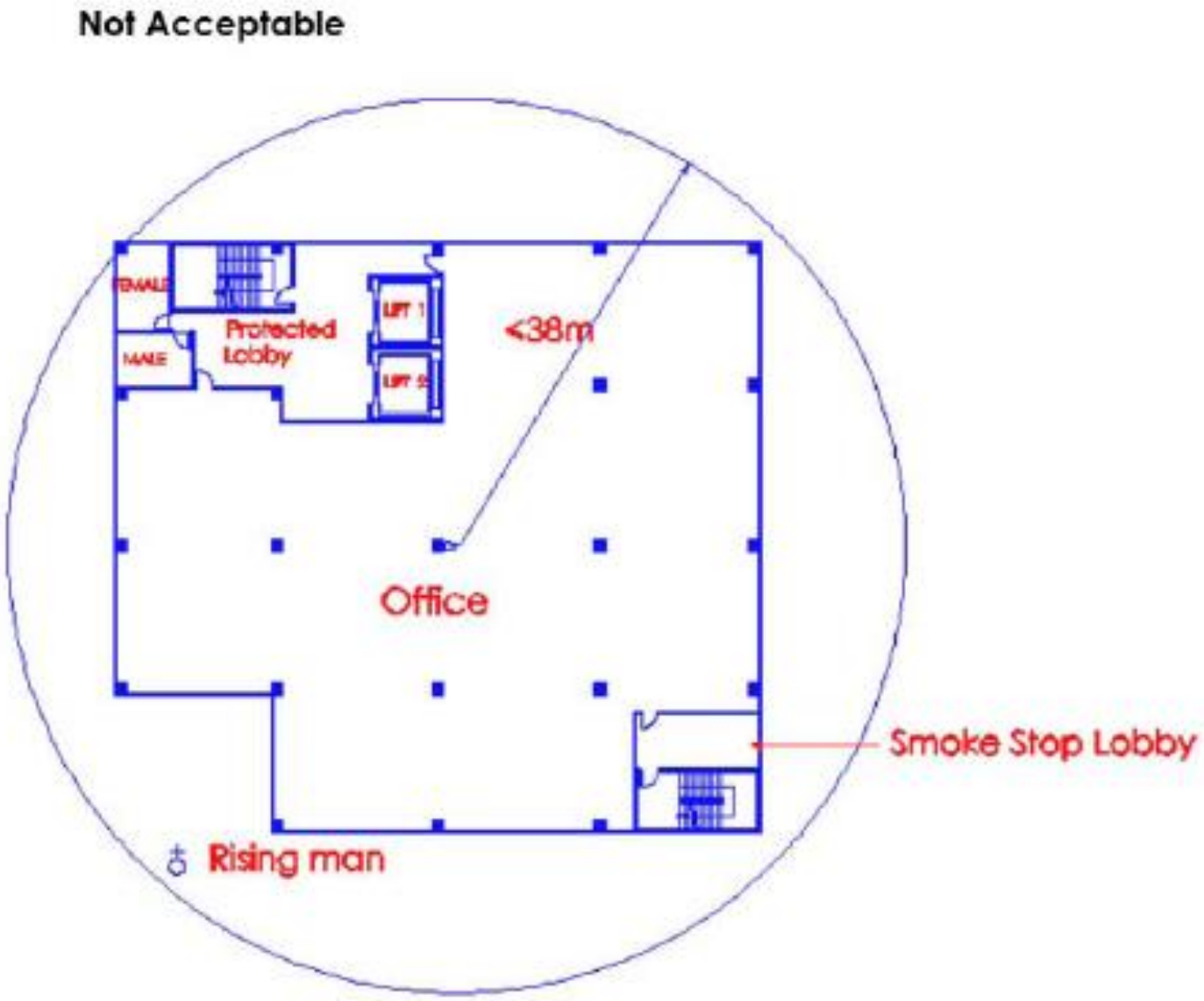
(iv) **Rising mains situated at various positions within same building**



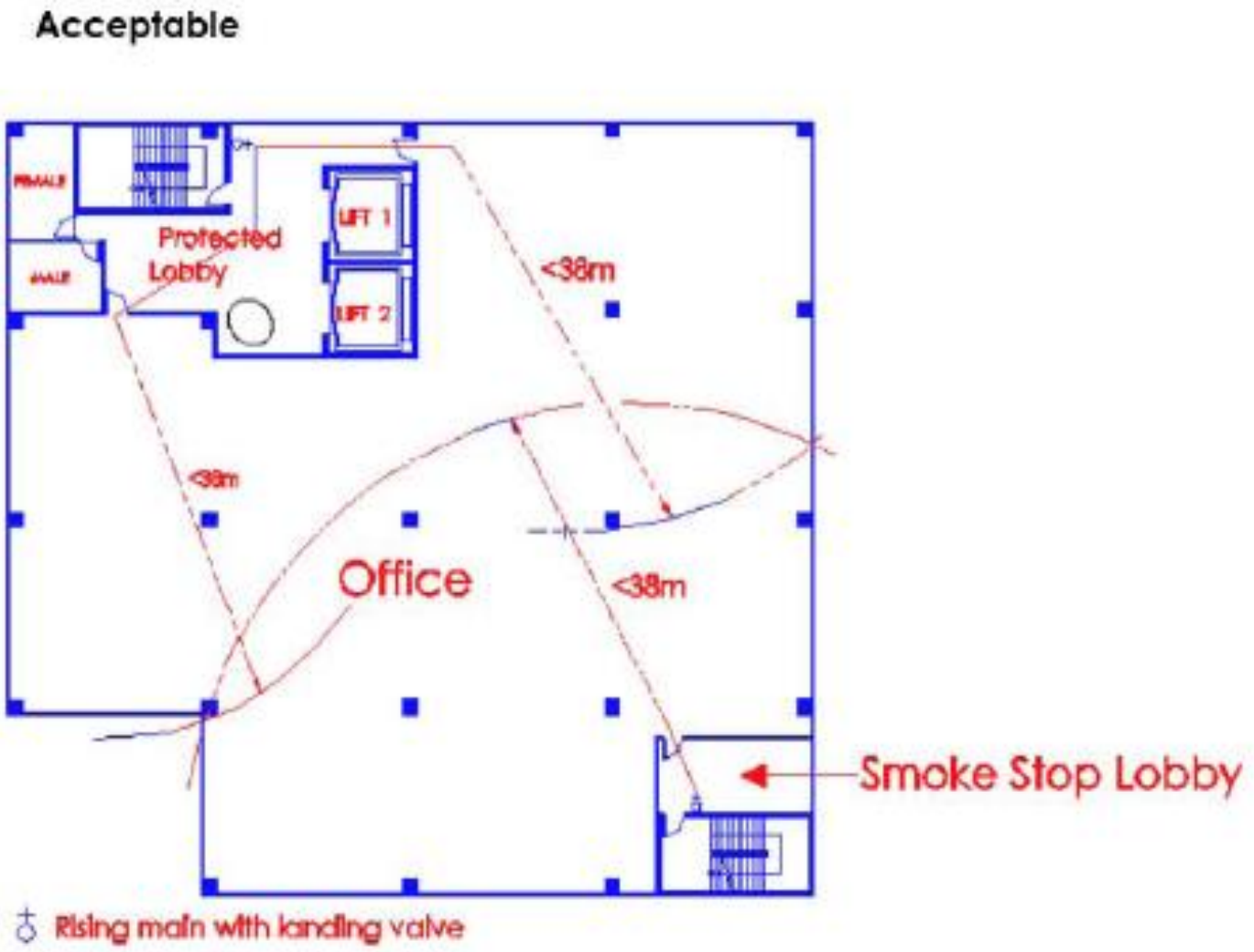
Position of Riser Main continued..



Position of Riser Main continued..



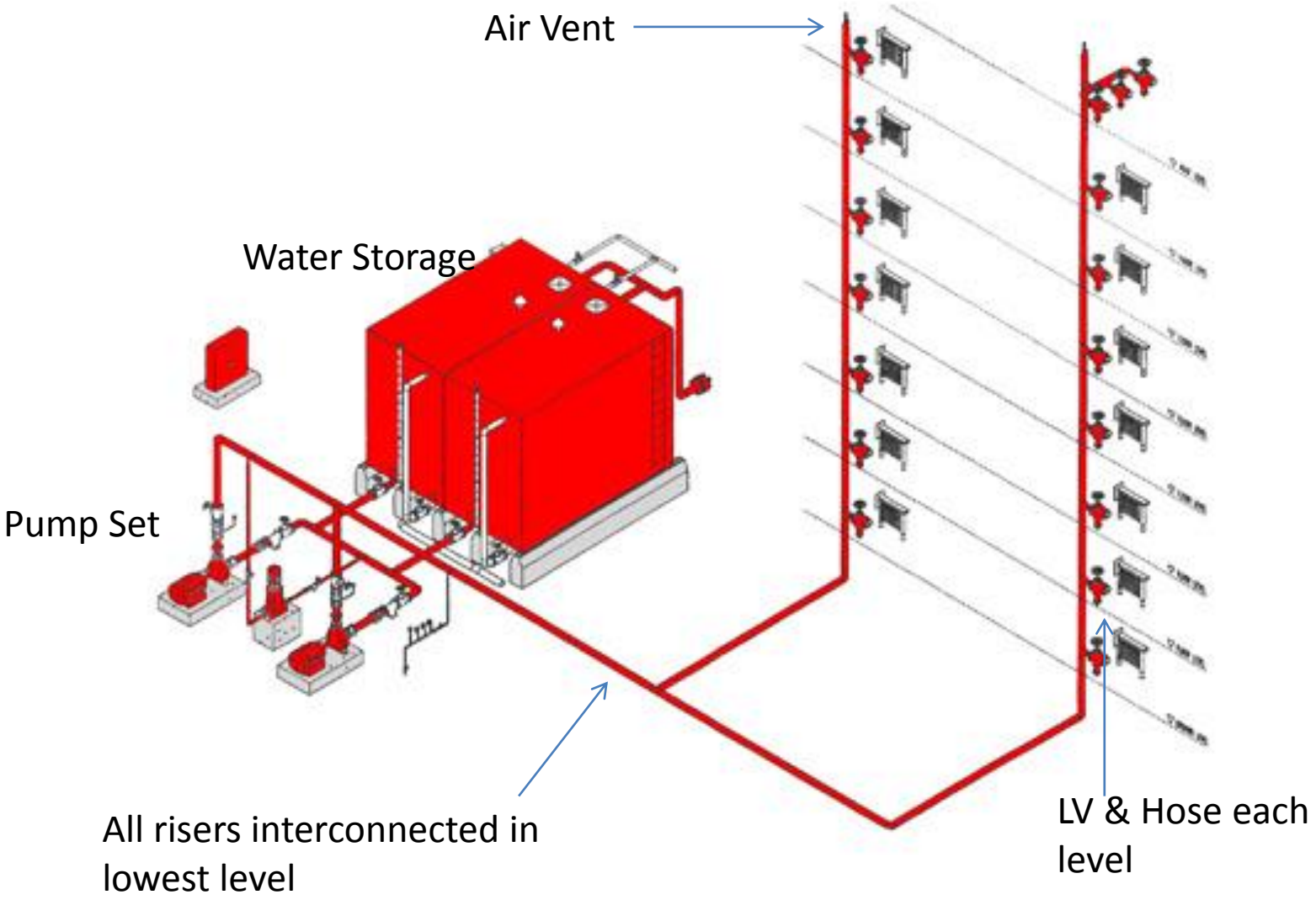
Position of Riser Main continued..



Pipe network

- Piping materials Shall be of galvanized steel to BSEN 10255 Class C ,BS 1387, ASTM Schedule 40. unless stated otherwise in the specific project specification.
- Expansion joints shall be incorporated in horizontal pipe run where connected to another building.
- For each riser
  - an automatic air vent shall be installed at the top most end
  - with an isolation valve &
  - pressure gauge.
- All risers shall be interconnected at the lowest floor level where there are two or more risers.
- Piping and accessories shall be
  - 65mm and above welded/ grooved/ flanged
  - 50mm and below threaded/ grooved
  - Any welding shall be cold galvanized

Piping Schematic



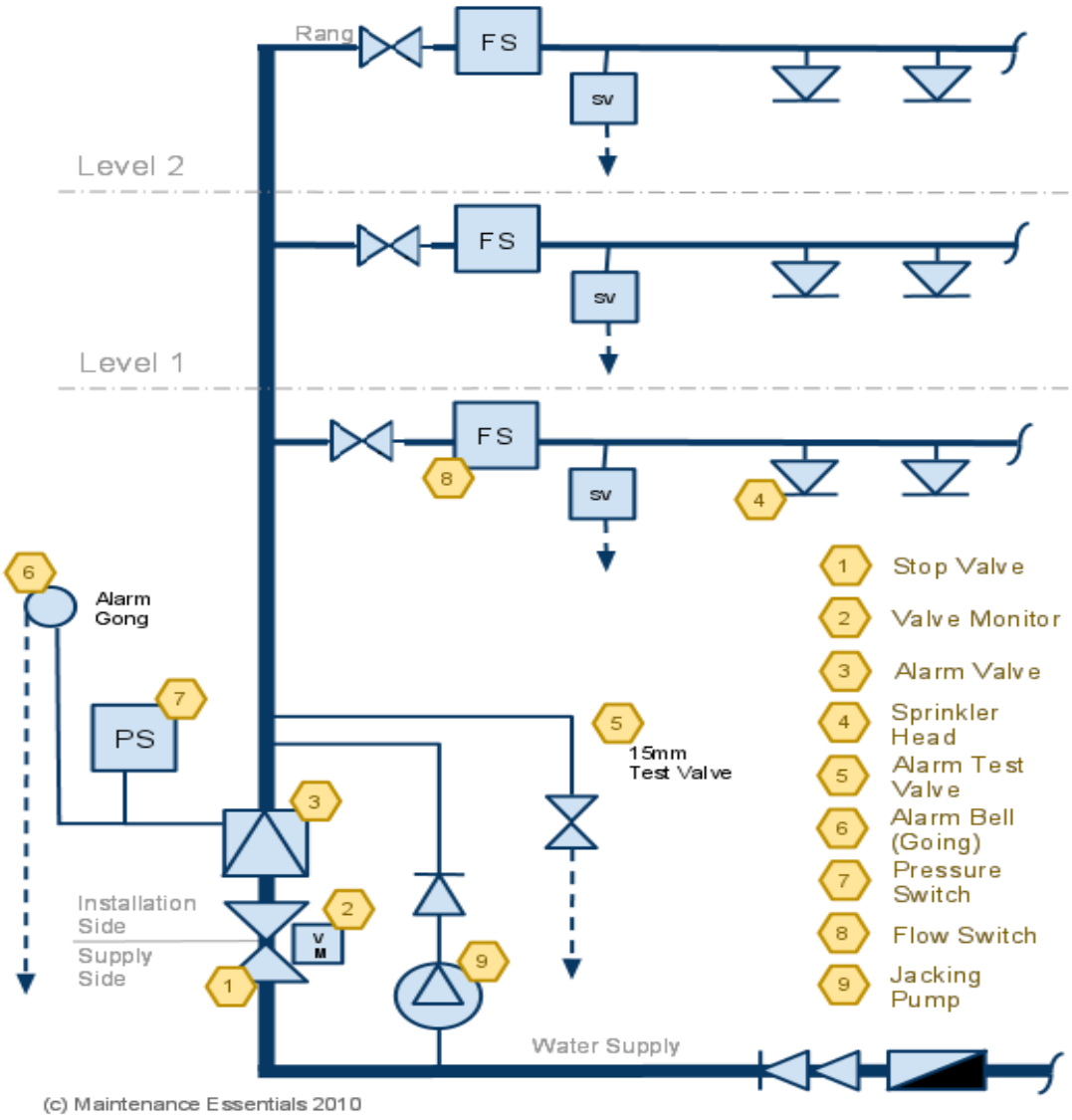
Sprinkler System

Sprinkler System

The System component are,

- Sprinkler heads and accessories
- Alarm Gong valve
- Stop valves(Zone isolation valves)
- Flow switches
- Piping system

Typical Schematic of a Sprinkler System



Sprinkler Heads

- Shall be UL listed or LPCB approved
- Shall be comply to NFPA 13 & BSEN 12845 design guide lines
- The distance between sprinklers shall not exceed 3.5 m
- Refer ICTAD Fire Regulation Chapter 4 for sprinkler
  - coverage area
  - distances
  - clearances from wall & soffit
- Sprinkler types shall be
  - Conventional Patten
  - Spry Patten
  - Celling or flush Patten
  - Recessed Patten
  - Concealed Patten
  - Sidewall Patten

Type of Sprinkler Head

Conventional

Upright

Pendent

Horizontal Sidewall

Vertical Sidewall

Recessed Pendent

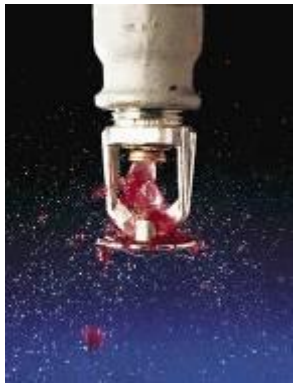
Recessed Pendent

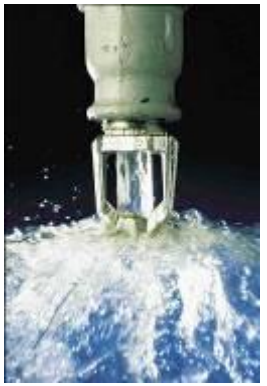
Concealed Horizontal Sidewall

Concealed Pendent

How do Sprinklers Work?

- Glass bulb contains a liquid with a vapour bubble
- Liquid expands as the temperature rises, compressing the vapour bubble
- At a set temperature (usually 68˚C) the bubble has gone and the side walls the bulb break, releasing the water seal



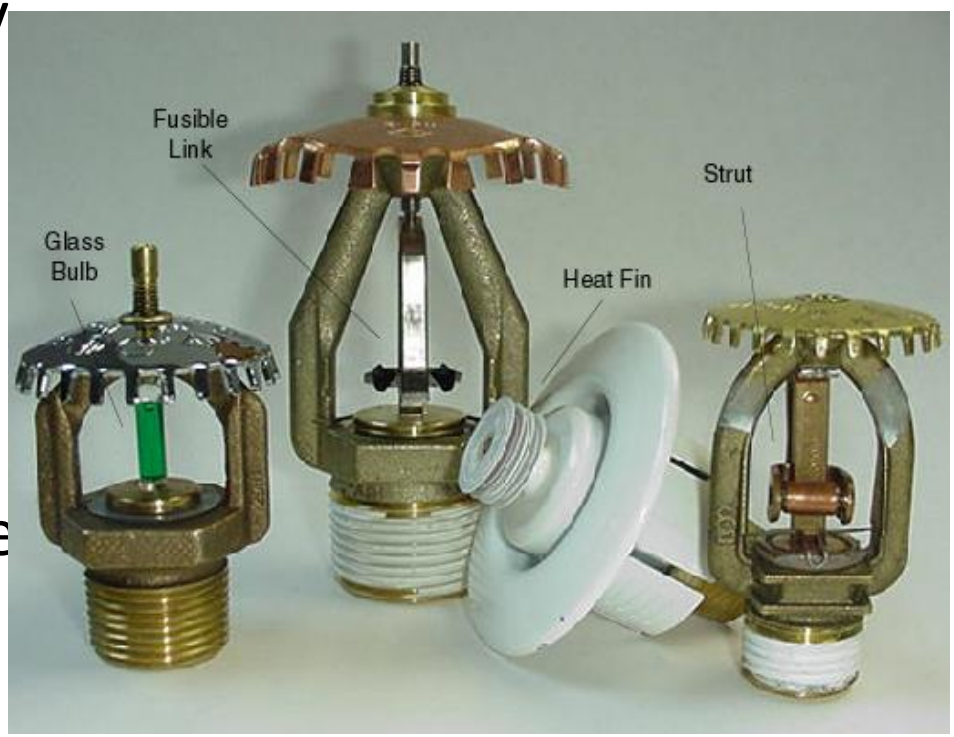
What’s the difference between sprinklers?

- **Thermal sensitivity**
- **Temperature rating**
- **Orifice size**
- **Installation**
- **Water distribution characteristics**
- **Special service conditions**

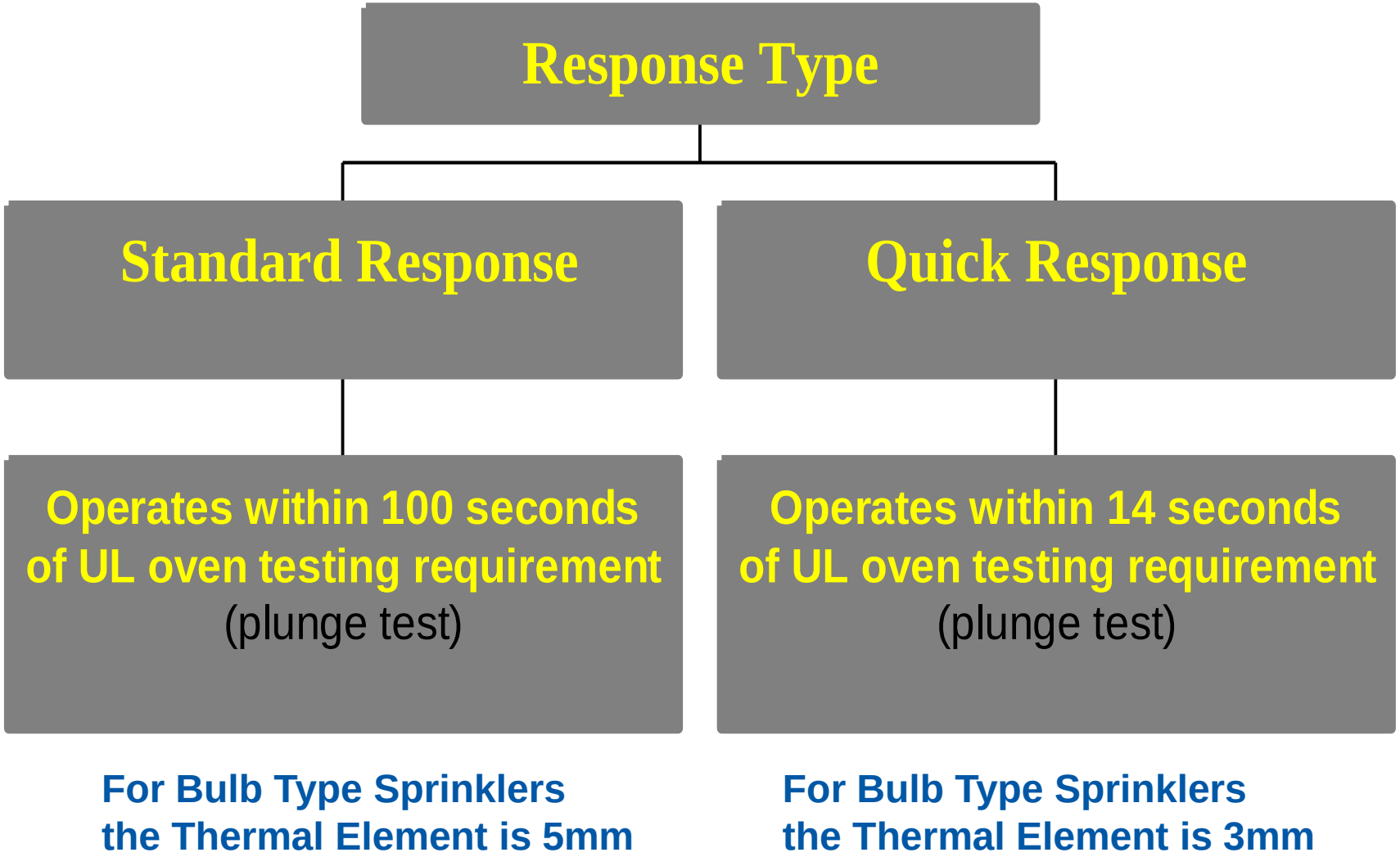
Thermal sensitivity

- A measure of the rapidity with which the thermal element operates as installed in a specific sprinkler or sprinkler assembly.

- One measure of thermal sensitivity is the response time index (RTI) as measured under standardized test conditions.



Sprinkler Response Types

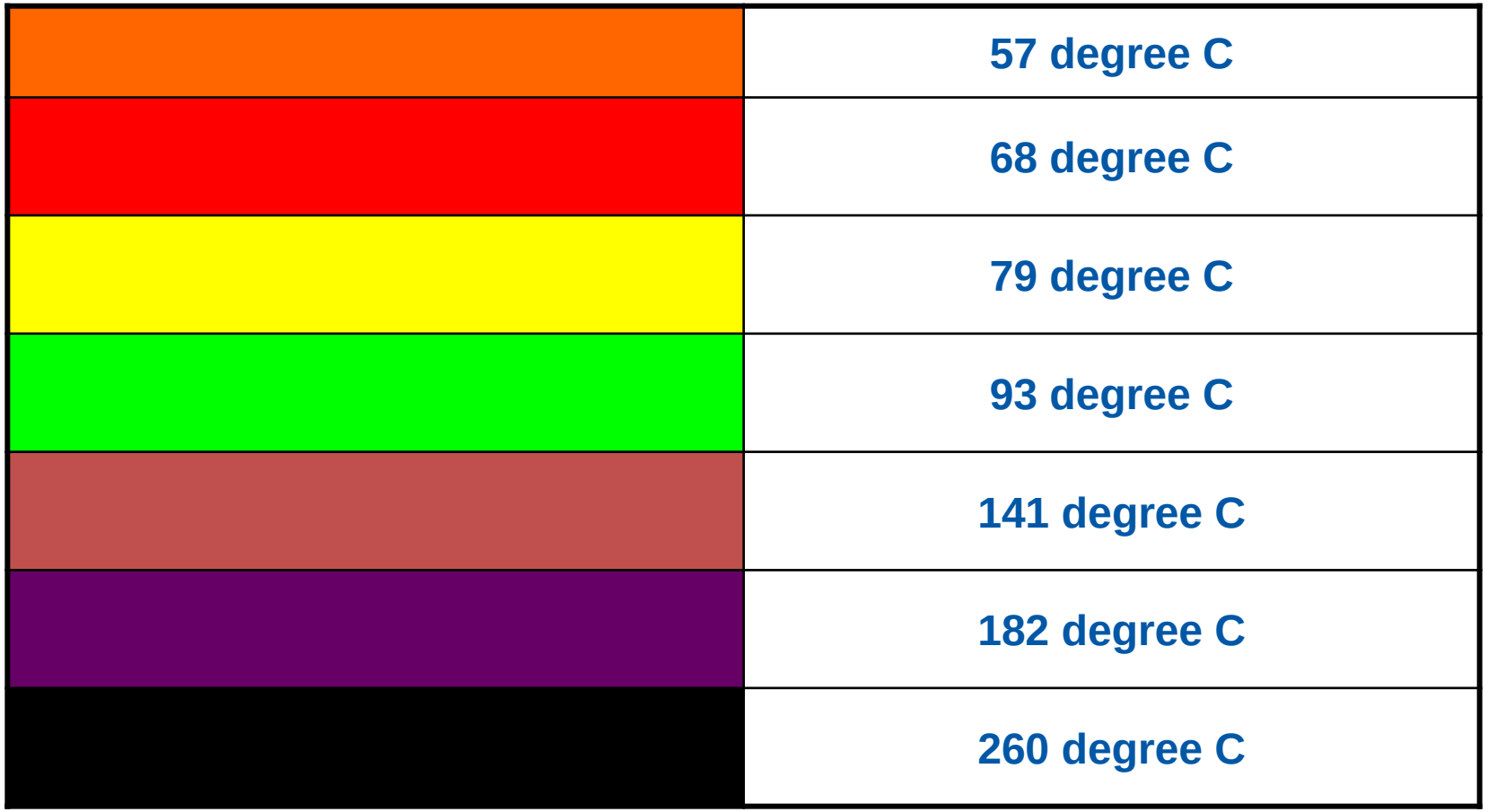


Response Time Index (RTI)

- **Standard Response (SR) – RTI from 80 to 120 (5mm dia. glass bulb)**

- **Quick Response (QR) – RTI below 50 (3mm dia. Glass bulb)**

Colors of Bulb/Temperature Rating



Temperature rating

Maximum Ceiling Temperature		Temperature Rating		Temperature Classification	Color Code	Glass Bulb Colors
°F	°C	°F	°C			
100	38	135–170	57–77	Ordinary	Uncolored or black	Orange or red
150	66	175–225	79–107	Intermediate	White	Yellow or green
225	107	250–300	121–149	High	Blue	Blue
300	149	325–375	163–191	Extra high	Red	Purple
375	191	400–475	204–246	Very extra high	Green	Black
475	246	500–575	260–302	Ultra high	Orange	Black
625	329	650	343	Ultra high	Orange	Black

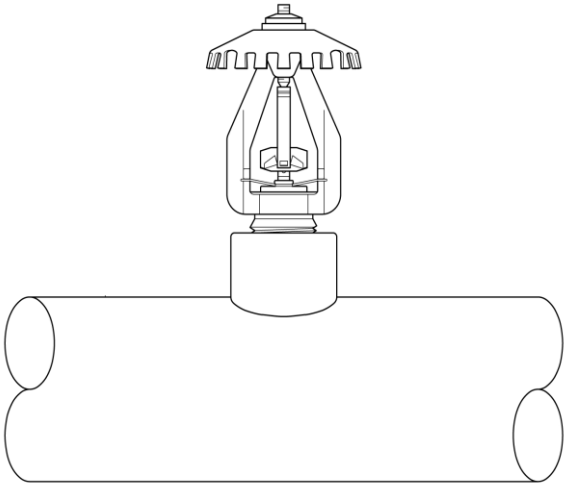
Orifice Size

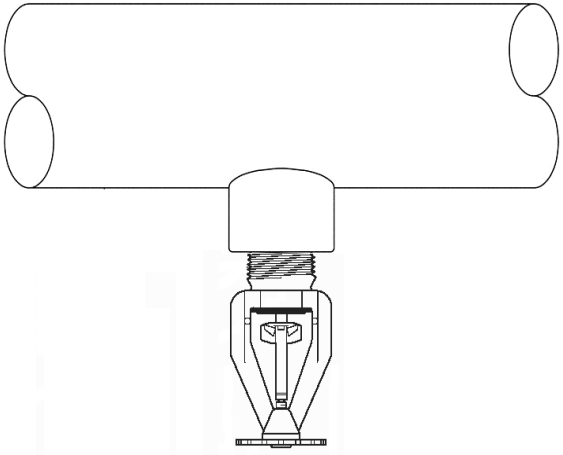
Nominal K-factor [gpm/(psi)$^{1/2}$]	K-factor Range [gpm/(psi)$^{1/2}$]	K-factor Range [dm^3/min/(kPa)$^{1/2}$]	Percent of Nominal K-5.6 Discharge	Thread Type
1.4	1.3–1.5	1.9–2.2	25	½ in. NPT
1.9	1.8–2.0	2.6–2.9	33.3	½ in. NPT
2.8	2.6–2.9	3.8–4.2	50	½ in. NPT
4.2	4.0–4.4	5.9–6.4	75	½ in. NPT
5.6	5.3–5.8	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

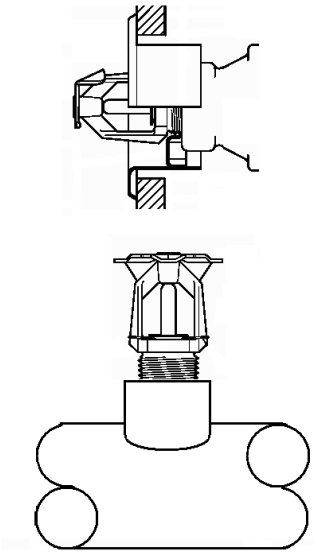
$Q = K (\sqrt{P})$

Q = Flow (gpm), K = K-factor (gpm/psi$^{1/2}$), and P = Pressure (psi)

Installation Orientation







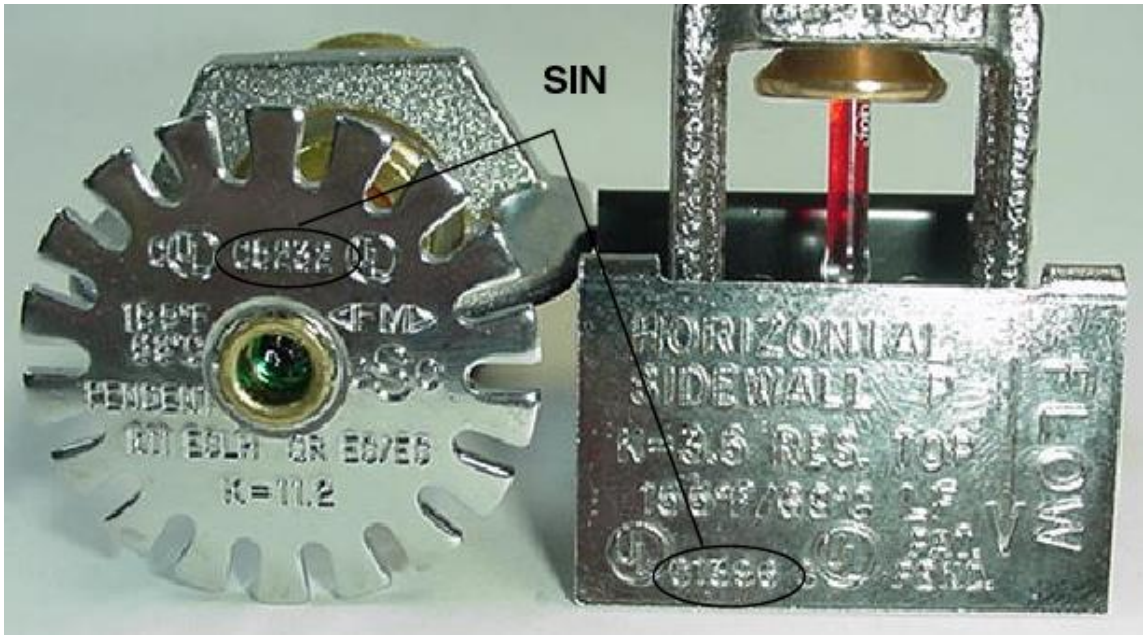
Upright

Pendent

Sidewall

Sprinkler Identification Numbers - SIN

NFPA 13 1999 Edition, Sect. 3-2.2 *"All sprinklers shall be permanently marked with a one or two character manufacturer symbol, followed by up to four numbers, so as to identify a unique model of sprinkler for every change in orifice size or shape, deflector characteristic, and thermal sensitivity. This rule shall become effective on January 1, 2001."*

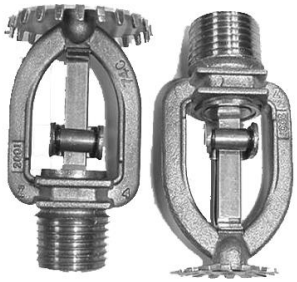


Sprinkler Heads *Continued ….*

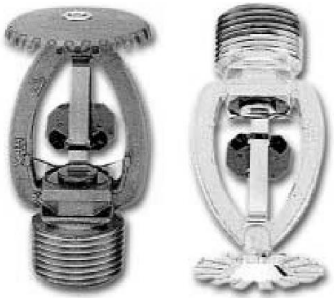
- Sprinkler glass bulb color coding as follows
  - Orange or red – temperature rating 57 to 77 ^{0}C
  - Yellow or green– temperature rating 79 to 107 ^{0}C
  - Blue– temperature rating 121 to 149 ^{0}C
  - Purple – temperature rating 163 to 191 ^{0}C
  - Black – temperature rating above 204 ^{0}C
- Sprinklers in car parking and hardware store areas shall be
  - pendant or upright bulb type
  - 12 mm diameter orifice
  - temperature rated to 68 ^{0}C
  - natural brass finishes with Sprinkler guard.

Standard Spray Upright & Pendent Sprinklers

2.8 - 8.0 K-factor



5.6 & 8.0 K-factor



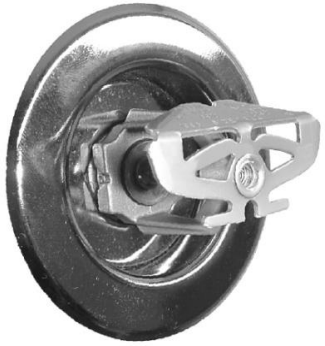
2.8 - 8.0 K-factor

11.2 K-factor

16.8 K-factor

5.6 K-factor

Standard Spray Sidewall Sprinklers

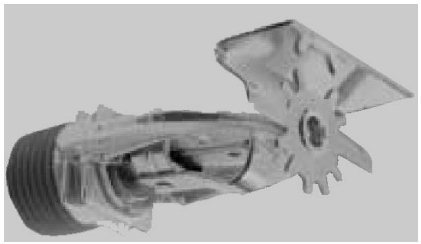


5.6 K-factor

Horizontal Sidewall

5.6 K-factor

Vertical Sidewall



5.6 K-factor

Horizontal Sidewall

2.8 – 5.6 K-factor

Horizontal Sidewall

Corrosion-Resistant Sprinkler

- A sprinkler fabricated with corrosion-resistant material, or with special coatings or platings, to be used in an atmosphere that would normally corrode sprinklers

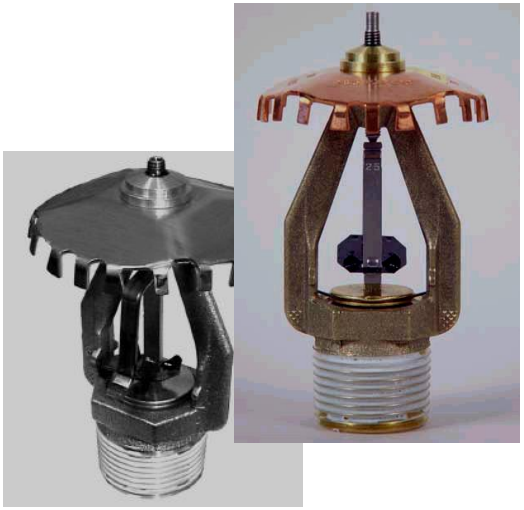
- All though corrosion resistant coated sprinklers have passed the standard corrosion tests of the approval agencies, the testing is not representative of all corrosive atmospheres

- Things to consider:
  - ambient temperature
  - concentration and corrosive nature of the chemical to which the sprinklers will be exposed.
  - gas/chemical velocity

Stainless Steel

Polyester

Extended Coverage Upright & Pendent Sprinklers



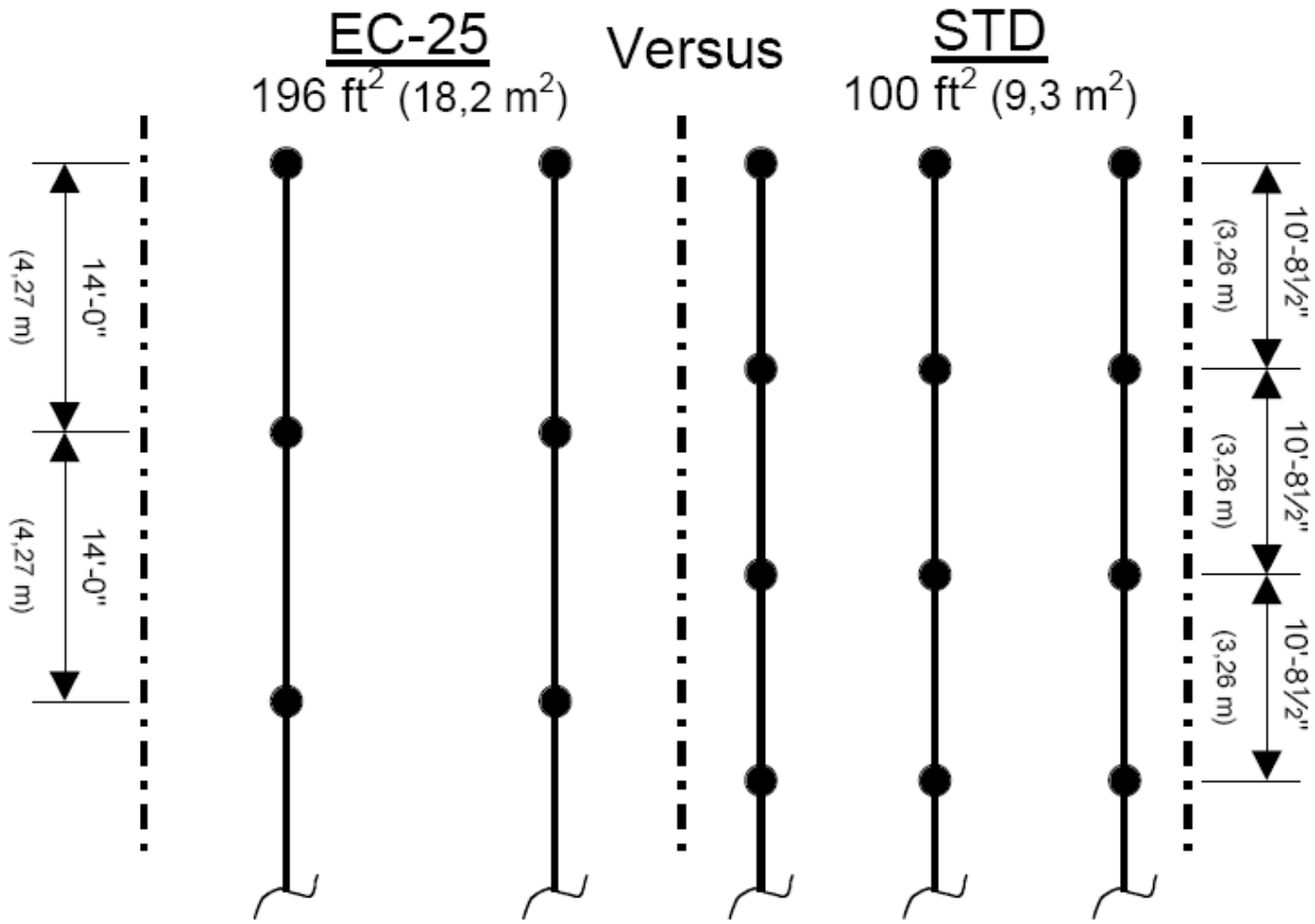
25.2 K-factor

11.2 & 14.0 K-factor

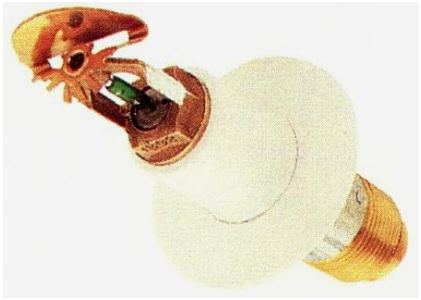
8.0 K-factor

5.6 & 11.2 K-factor

Extended Coverage vs Standard



Dry Sprinklers



5.6 K-factor Standard Coverage Upright, Pendent & Horizontal Sidewall; ECLH Horizontal Sidewall

11.2 K-factor Standard Coverage Pendent; ECLH/ECOH Pendent

Special Sprinklers

5.6 & 8.0 K-factor Attic Sprinklers

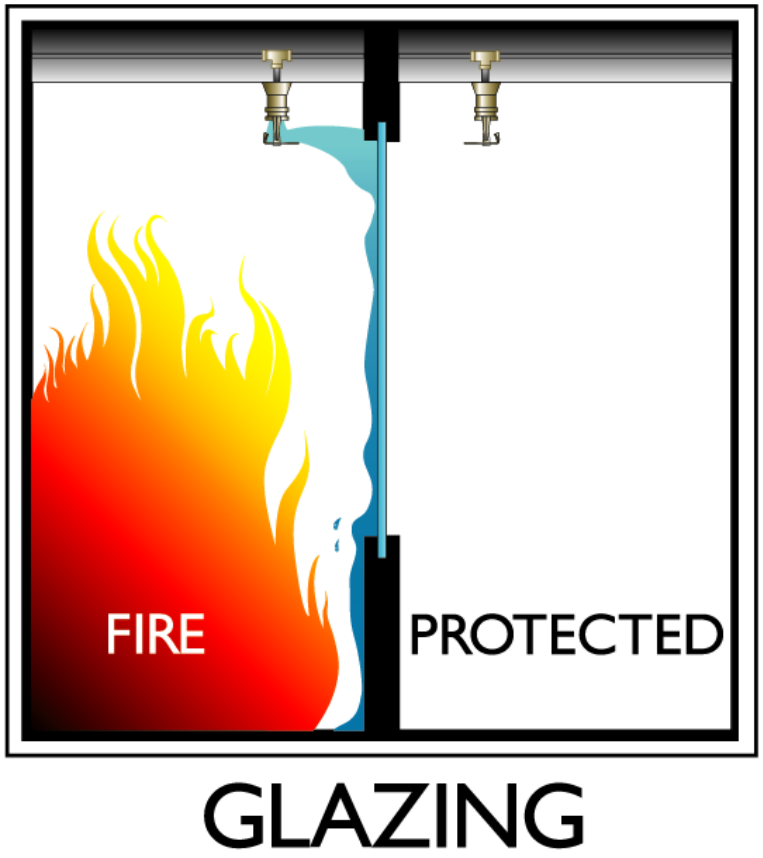
5.6 K-factor Window Sprinklers

3.0 K-factor Combustible Concealed Space Sprinklers

Specific Application: Window Sprinkler

- These sprinklers are the first sprinklers ever to be specifically Listed to provide protection for heat strengthened or tempered glass windows using automatic sprinklers.

- These sprinklers are also recognized by UL as providing a two-hour equivalency for a fire separation assembly.



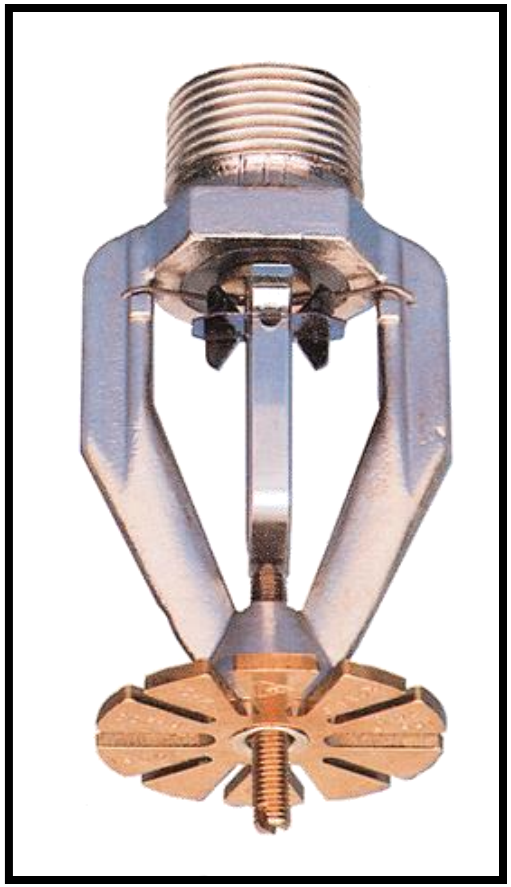
What is ESFR

EARLY

SUPPRESSION

FAST

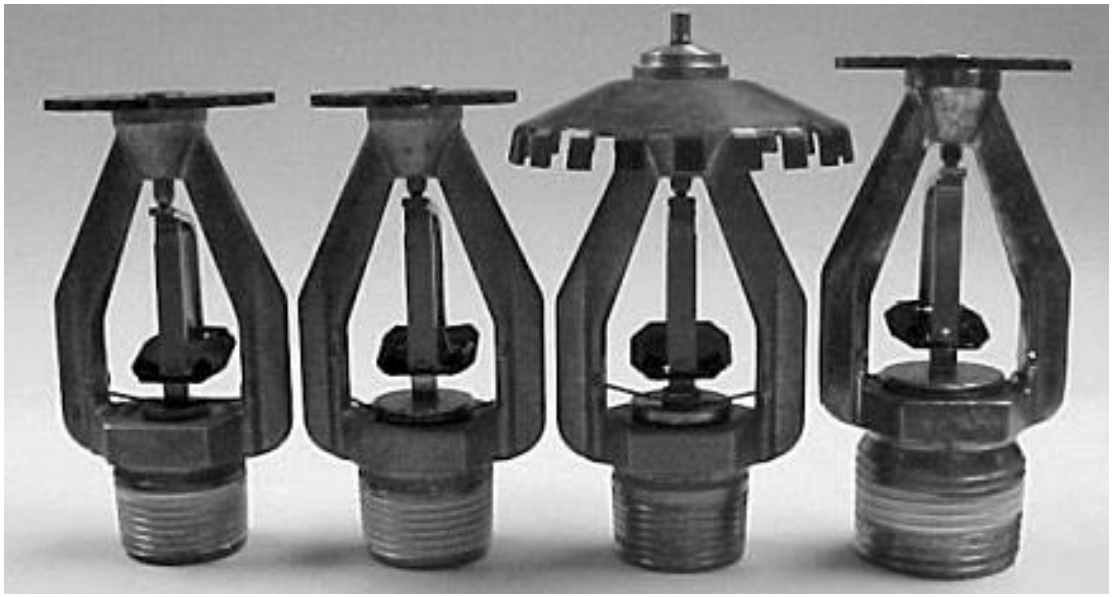
RESPONSE



ESFR Sprinklers

Early Suppression Fast-Response (ESFR) Sprinkler.

A type of fast-response sprinkler that is listed for its capability to provide fire suppression of specific high challenge fire hazards such as server rooms/files rooms



14.0 K-factor	***16.8 K-factor***	***25.2 K-factor***
Pendent	***Pendent & Upright***	***Pendent***

Sample Data sheet

K	TYPE	TEMP. RATING	FRAME COLOR CODE	SPRINKLER FINISH				
				NATURAL BRASS	CHROME PLATED	LEAD COATED	WAX COATED	WAX OVER LEAD COATED
5.6 1/2" NPT	PENDENT (TY3211) and UPRIGHT (TY3111)	165°F/74°C	Unpainted	1, 2, 3, 5		1, 2, 3		
		212°F/100°C	White					
		280°F/138°C	Blue			1, 2	4	N/A
	RECESSED PENDENT (TY3211 w/ Style 20)	165°F/74°C	Unpainted	1, 2, 3, 5		N/A		
		212°F/100°C	White	1, 2, 3, 5				

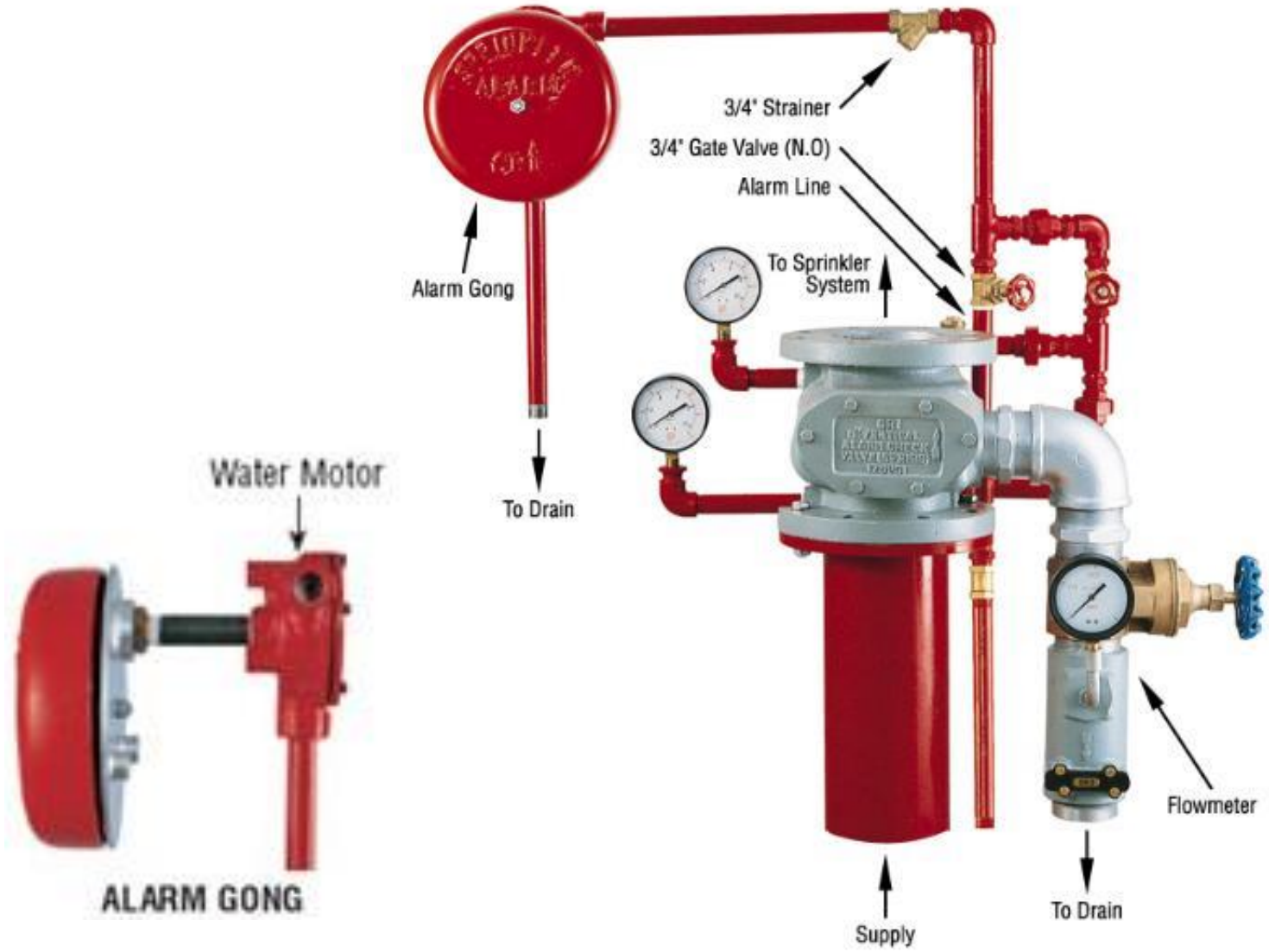
NOTES:
1. Listed by Underwriters Laboratories, Inc. (UL).
2. Listed by Underwriters Laboratories, Inc. for use in Canada (C-UL).
3. Approved by Factory Mutual Research Corporation (FM).
4. Approved by Factory Mutual Research Corporation (FM) for maximum 150°F/68°C ambient temperatures.
5. Approved by the Loss Prevention Certification Board (LPCB Ref. No. 094a/03).

N/A: Not Available

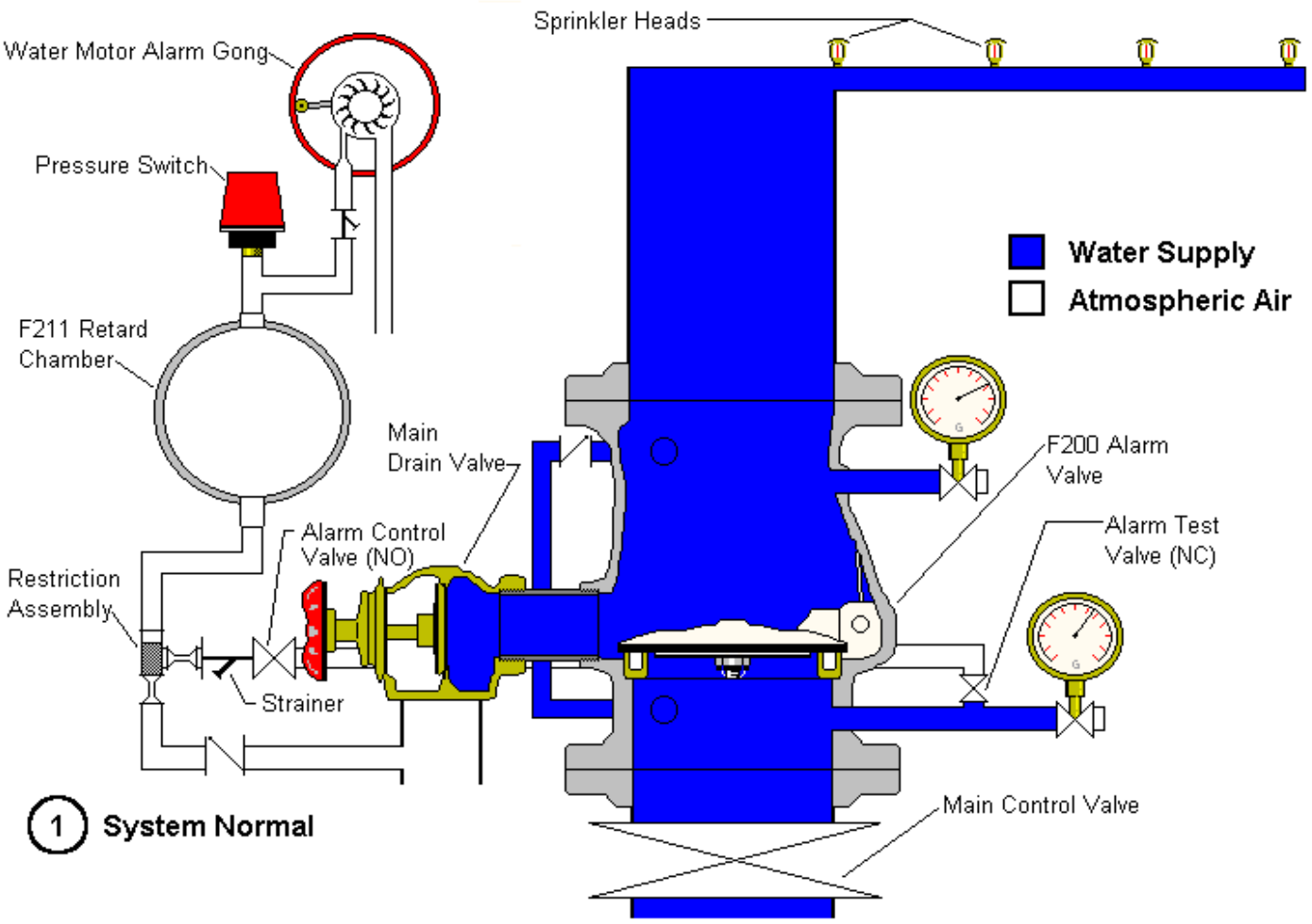
Water Motor Alarm Gong

- Shall be UL listed or LPCB approved
- Shall be hydraulically operated for outdoor alarms
- Designed as mechanical water flow detection devices.
- Shall be suitable for mounting in rigid walls
- Consist of an approved “Y” strainer for use in the alarm pipe line
- Alarm Gong Impeller should design which can produce a very high sound pressure level.

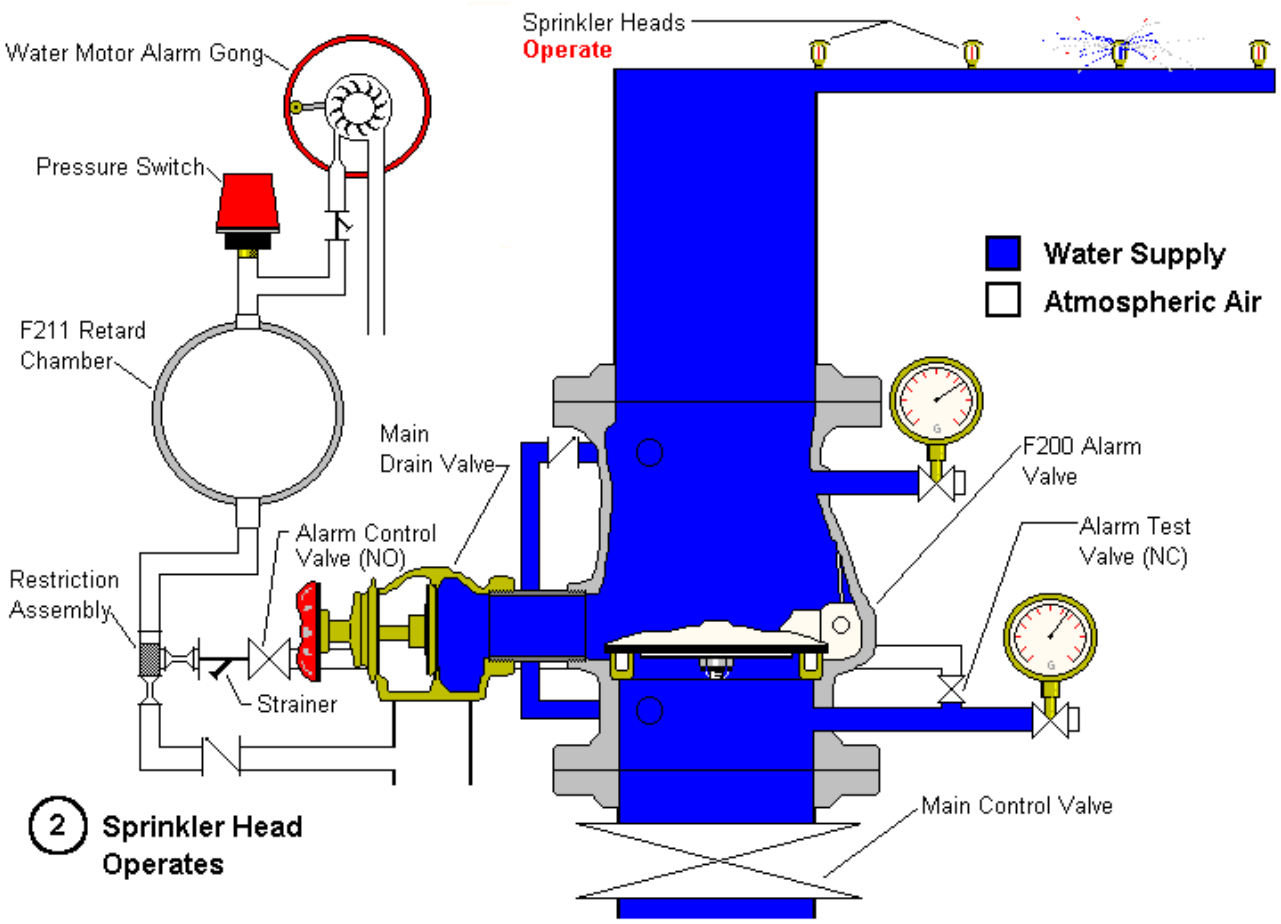
The Arrangement of Water Motor Alarm Gong



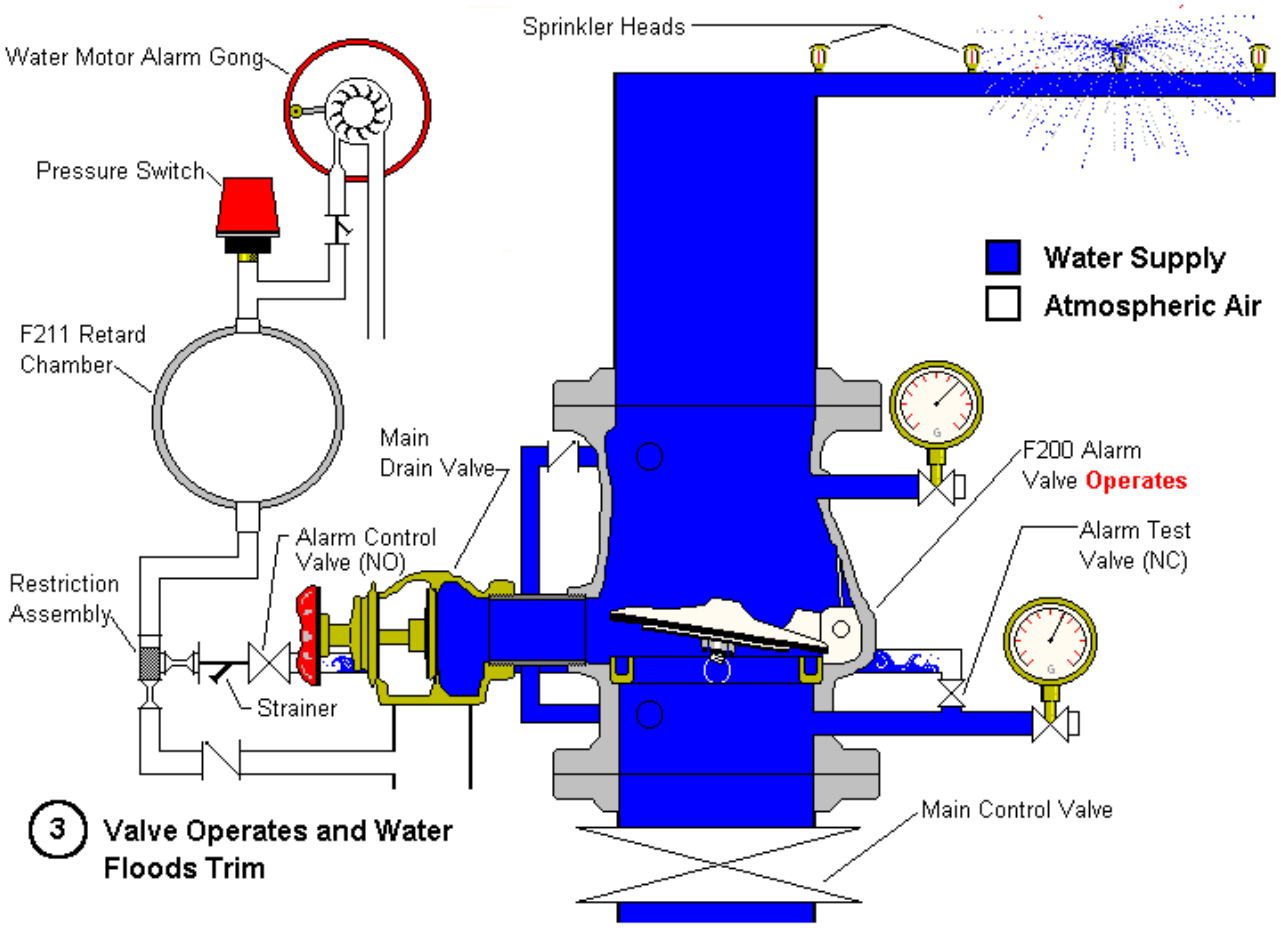
Alarm Valve Operation Procedure



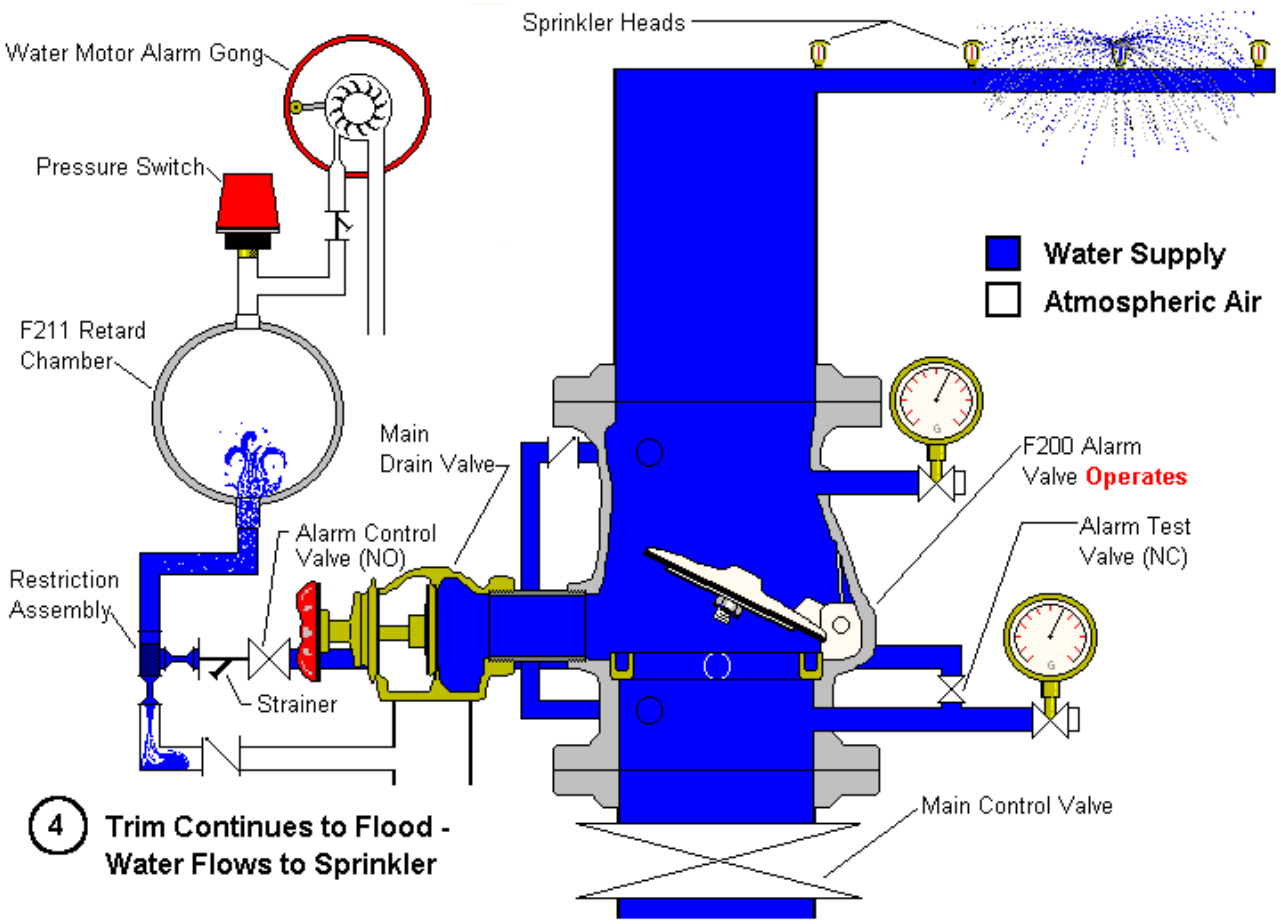
Alarm Valve Operation Procedure



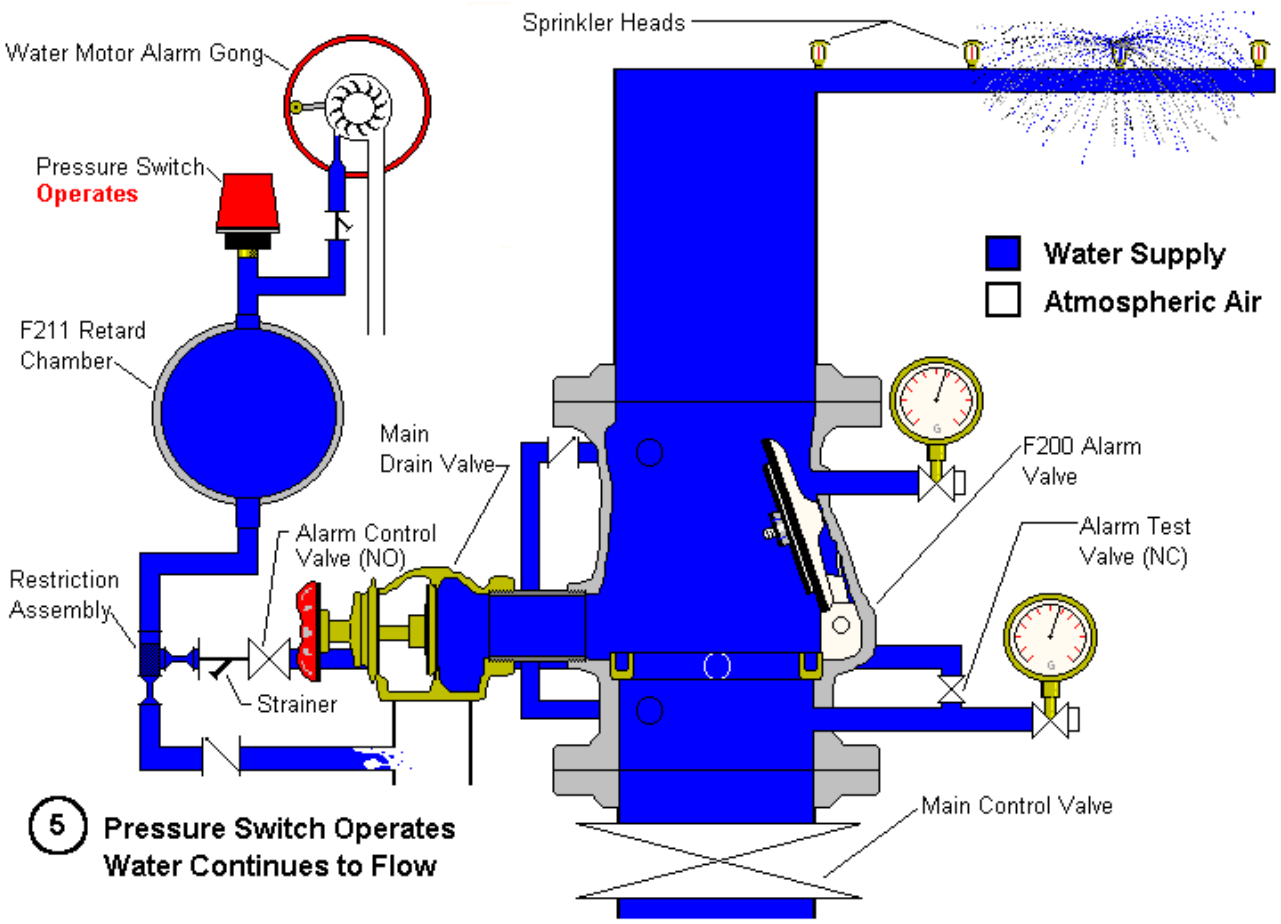
Alarm Valve Operation Procedure



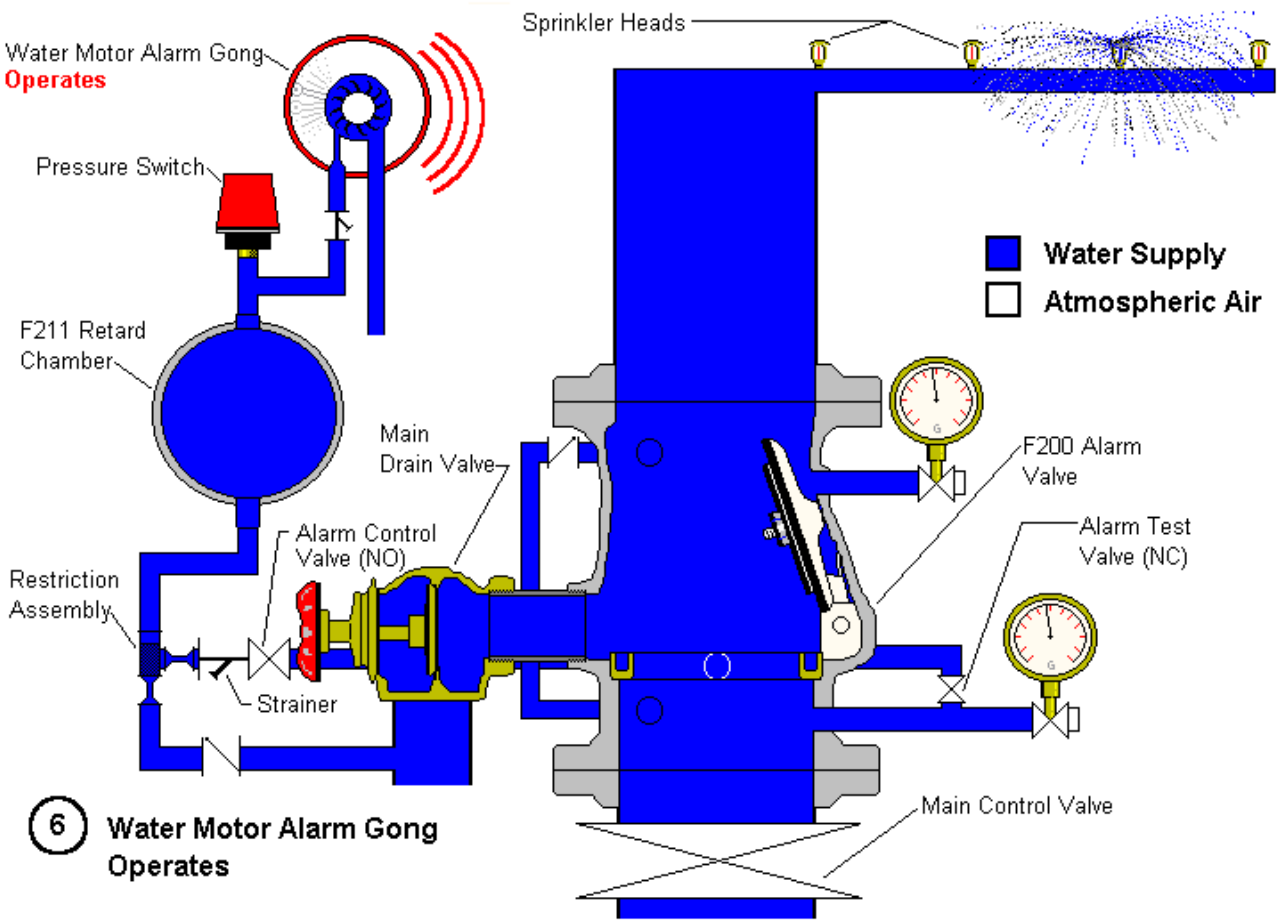
Alarm Valve Operation Procedure



Alarm Valve Operation Procedure



Alarm Valve Operation Procedure



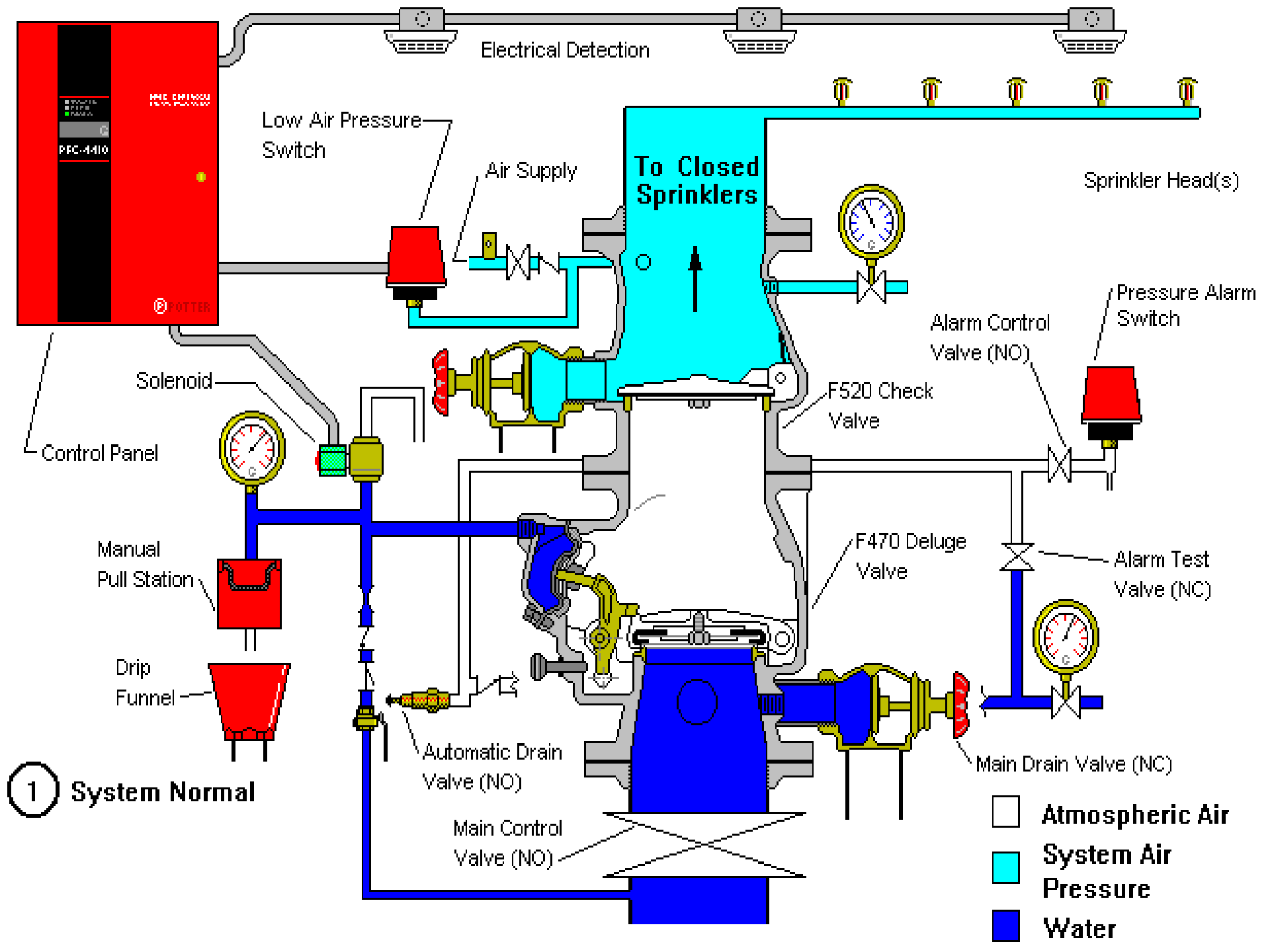
Type of Pre-action Systems

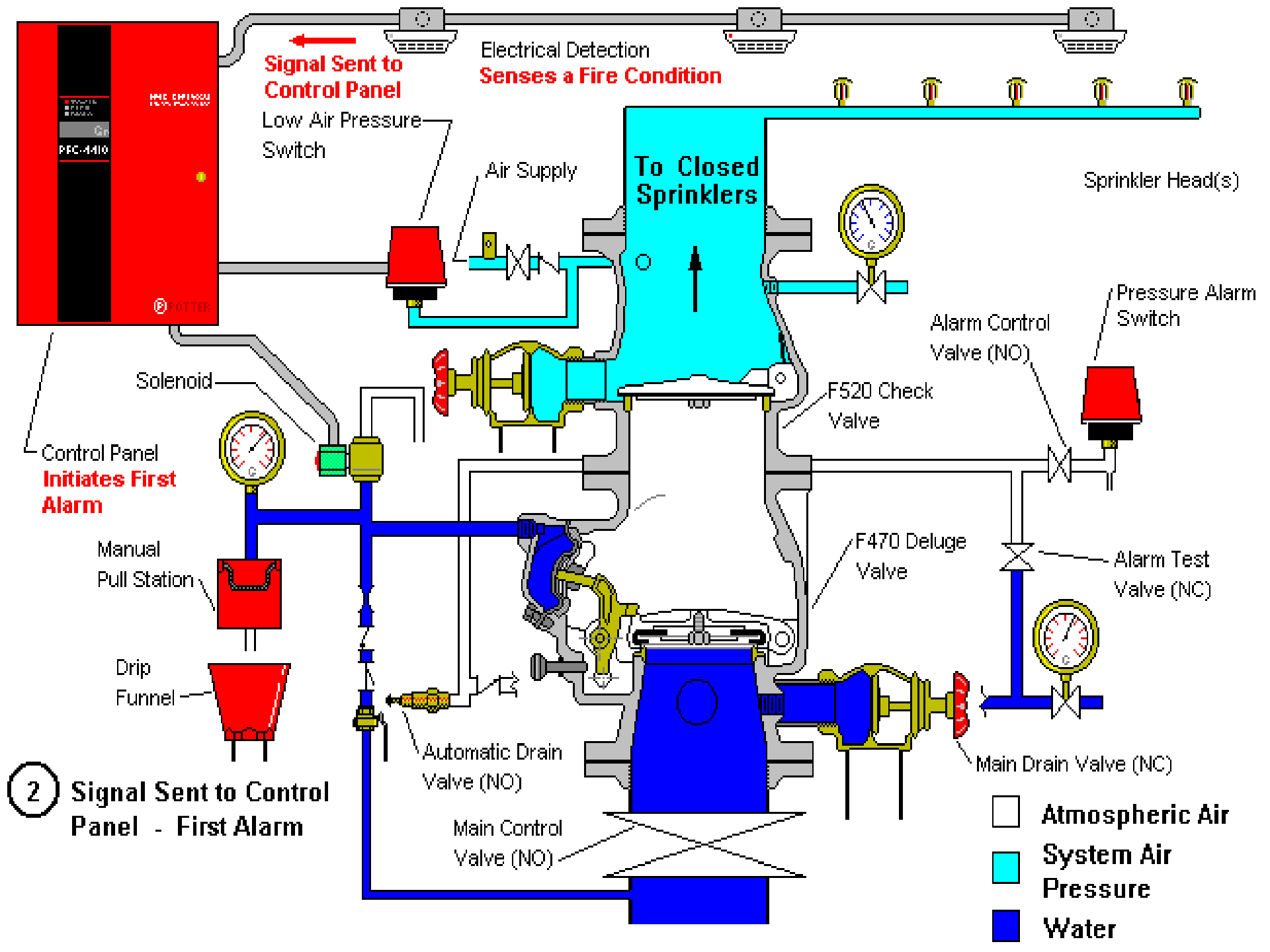
Single Interlock:

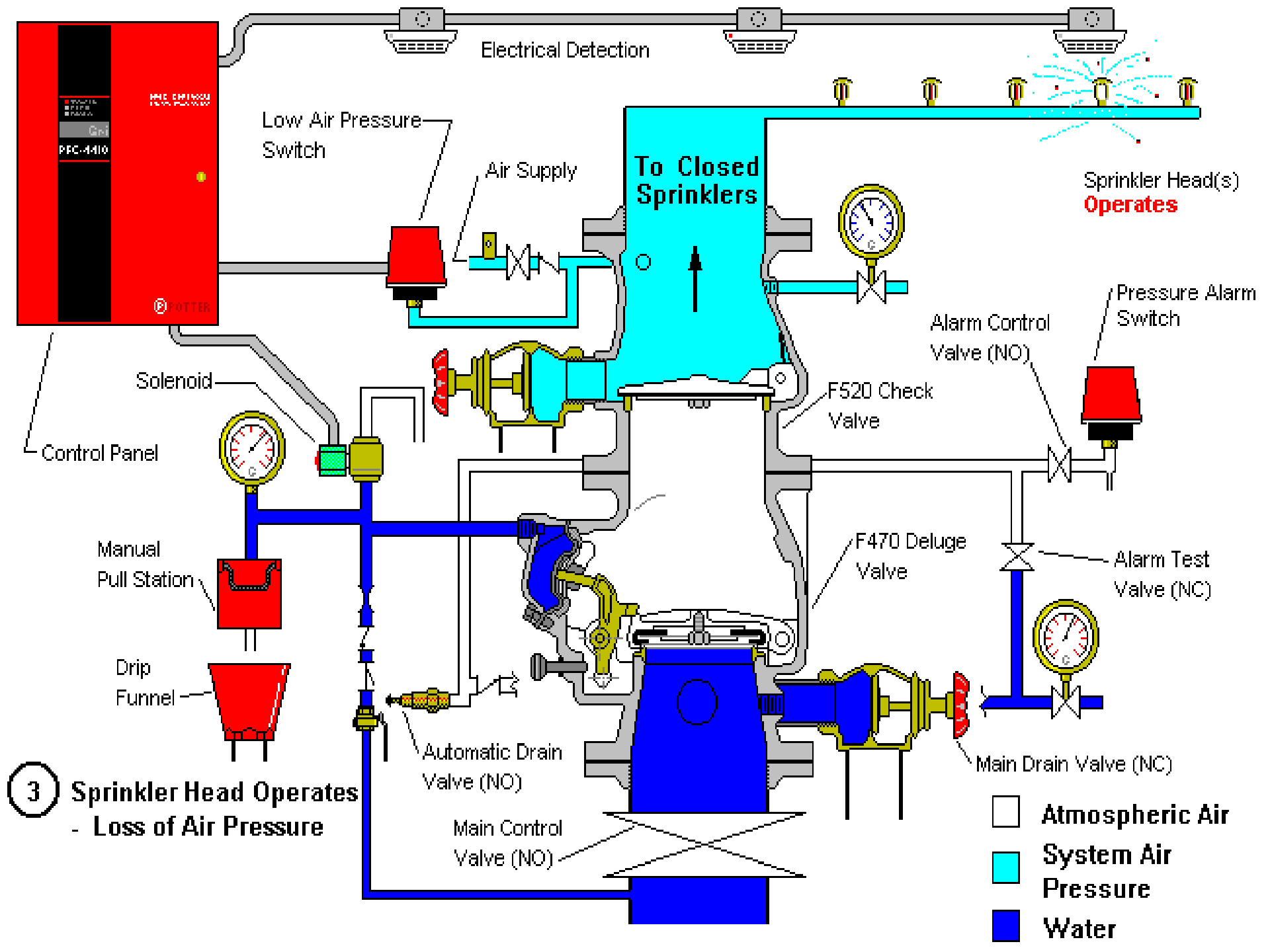
-Electric Actuation (using smoke or heat detectors)
-Wet Pilot Actuation (using pilot sprinklers, pilot line with water)
-Dry pilot actuation (using pilot sprinklers, pilot line with compressed air)

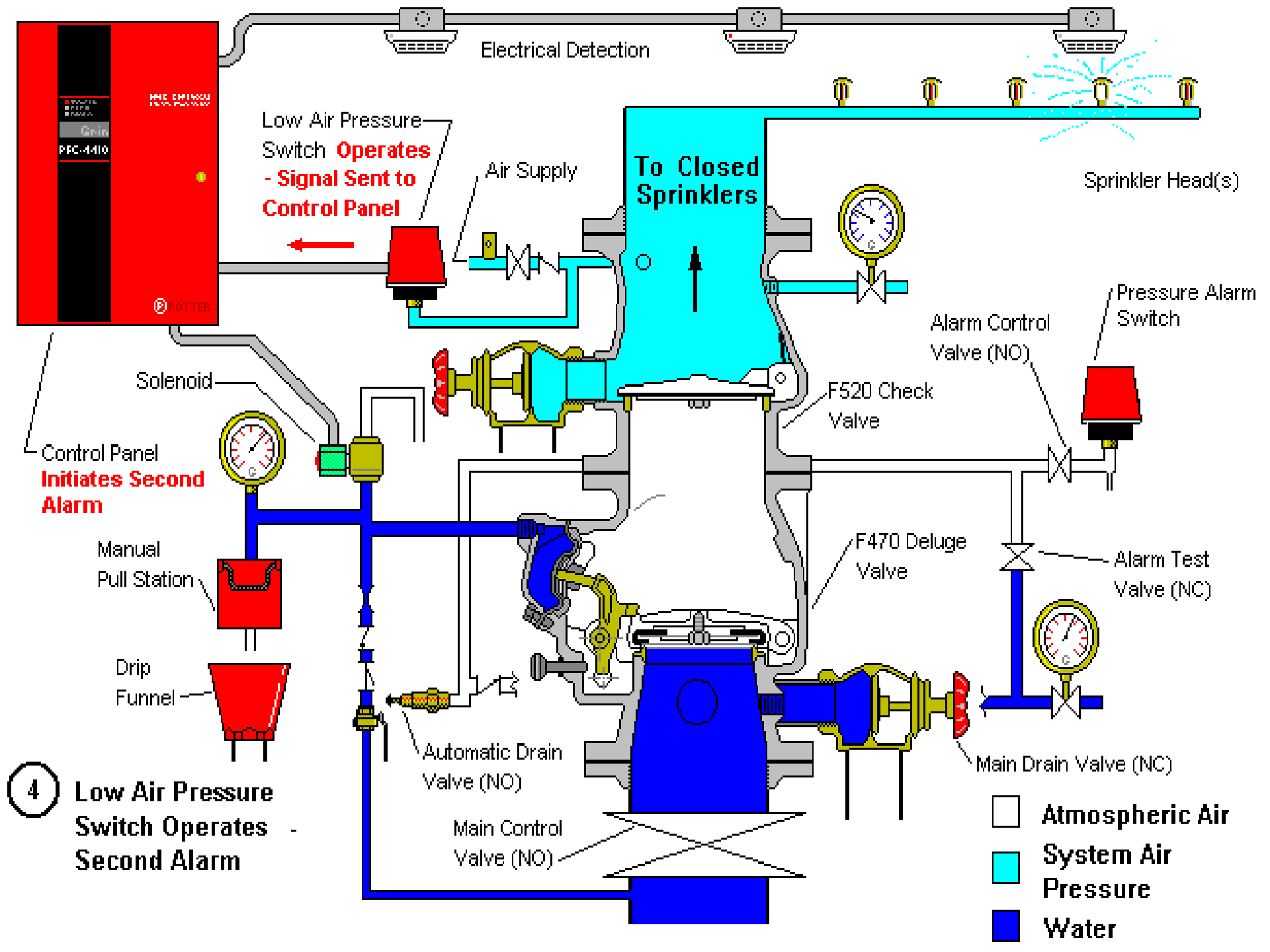
Double Interlock:

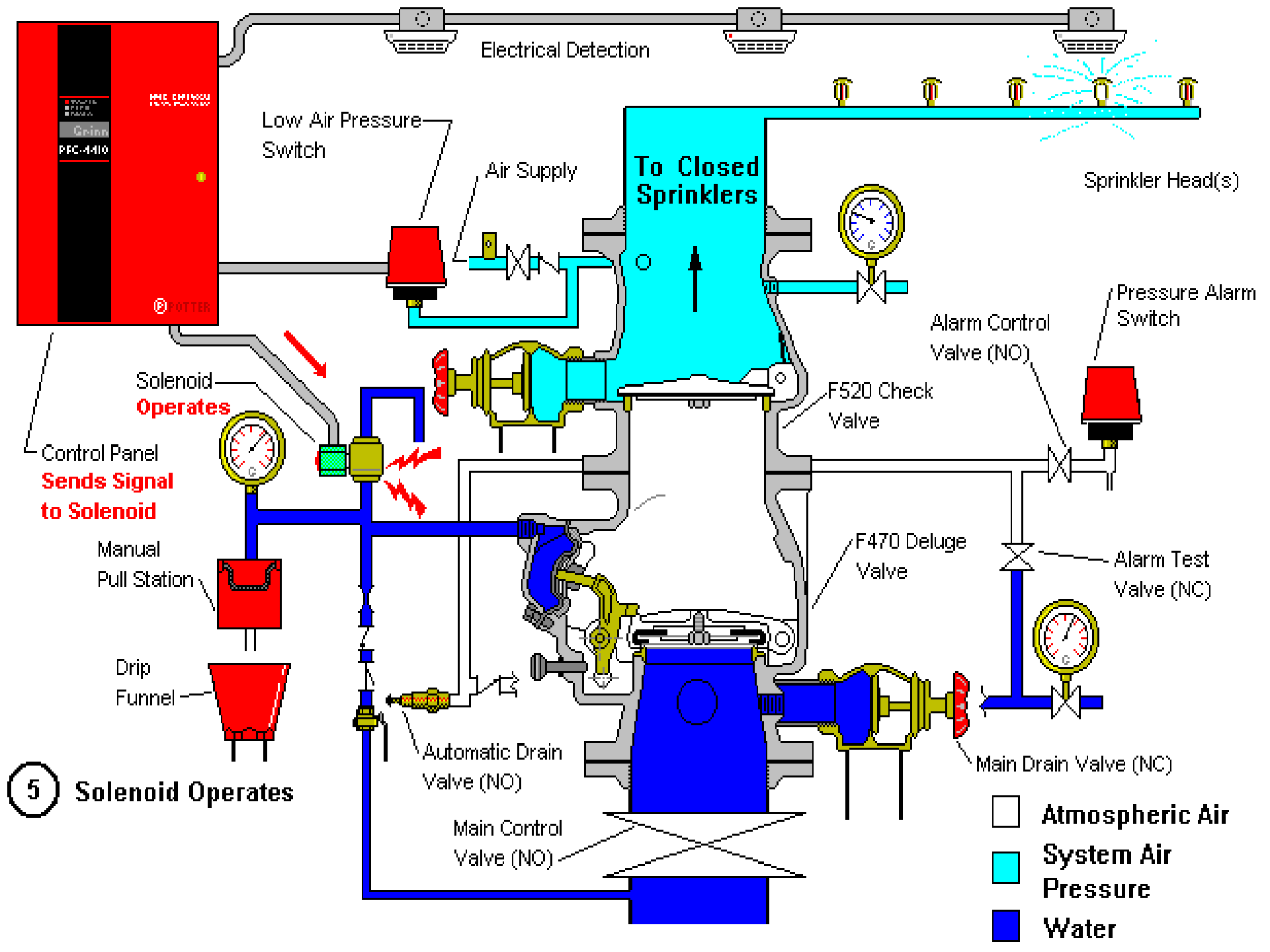
-Electric/ Electric (cross zoning of detectors)
-Electric / Pneumatic (Detectors with low air pressure switch)

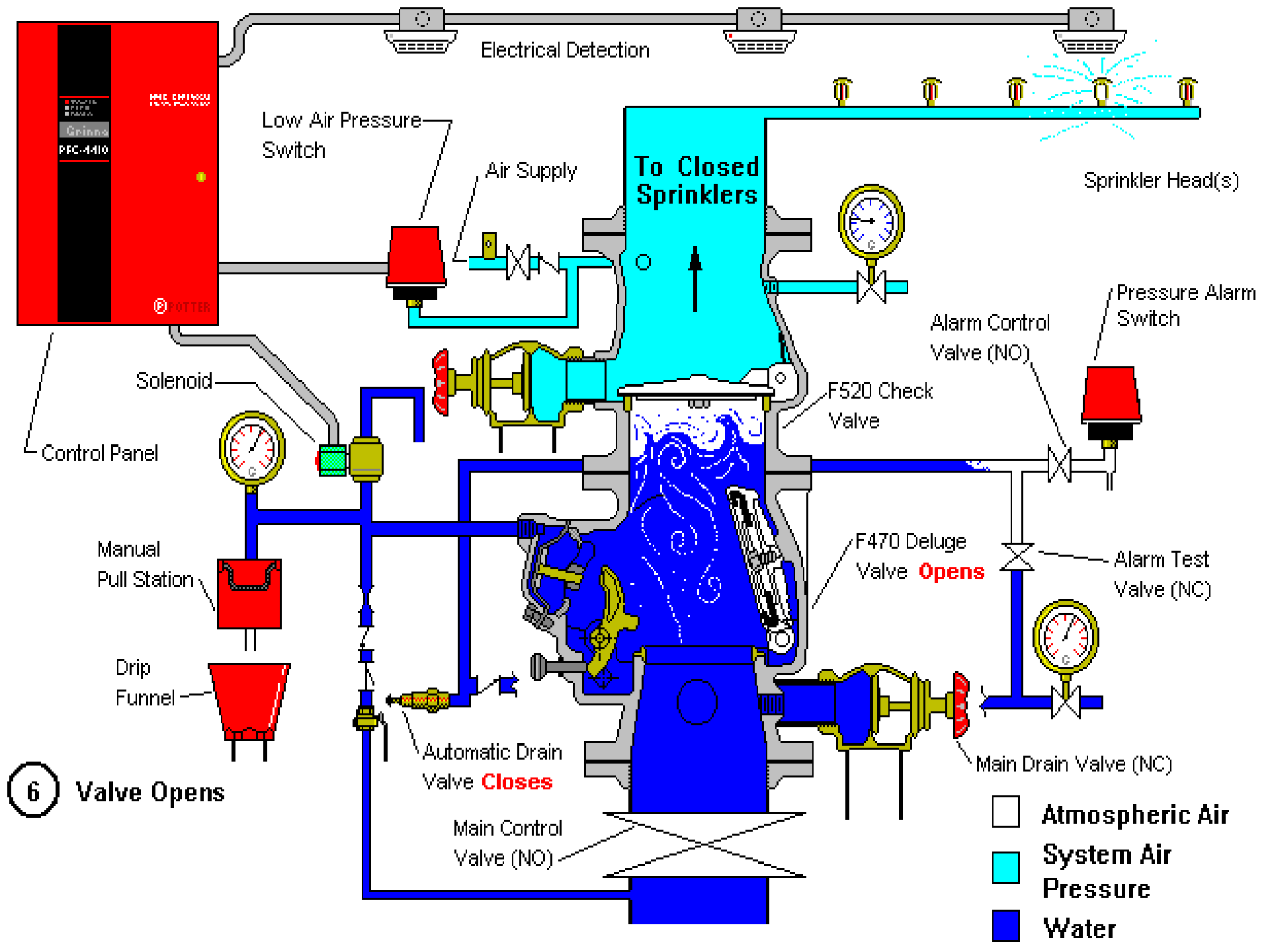

Electrical Detection
Low Air Pressure Switch
Air Supply
To Closed Sprinklers
Sprinkler Head(s)
Pressure Alarm Switch
Alarm Control Valve (NO)
Solenoid
F520 Check Valve
Control Panel
Manual Pull Station
F470 Deluge Valve
Alarm Test Valve (NC)
Drip Funnel
Automatic Drain Valve (NO)
Main Drain Valve (NC)
Main Control Valve (NO)
1 System Normal
Atmospheric Air
System Air Pressure
Water

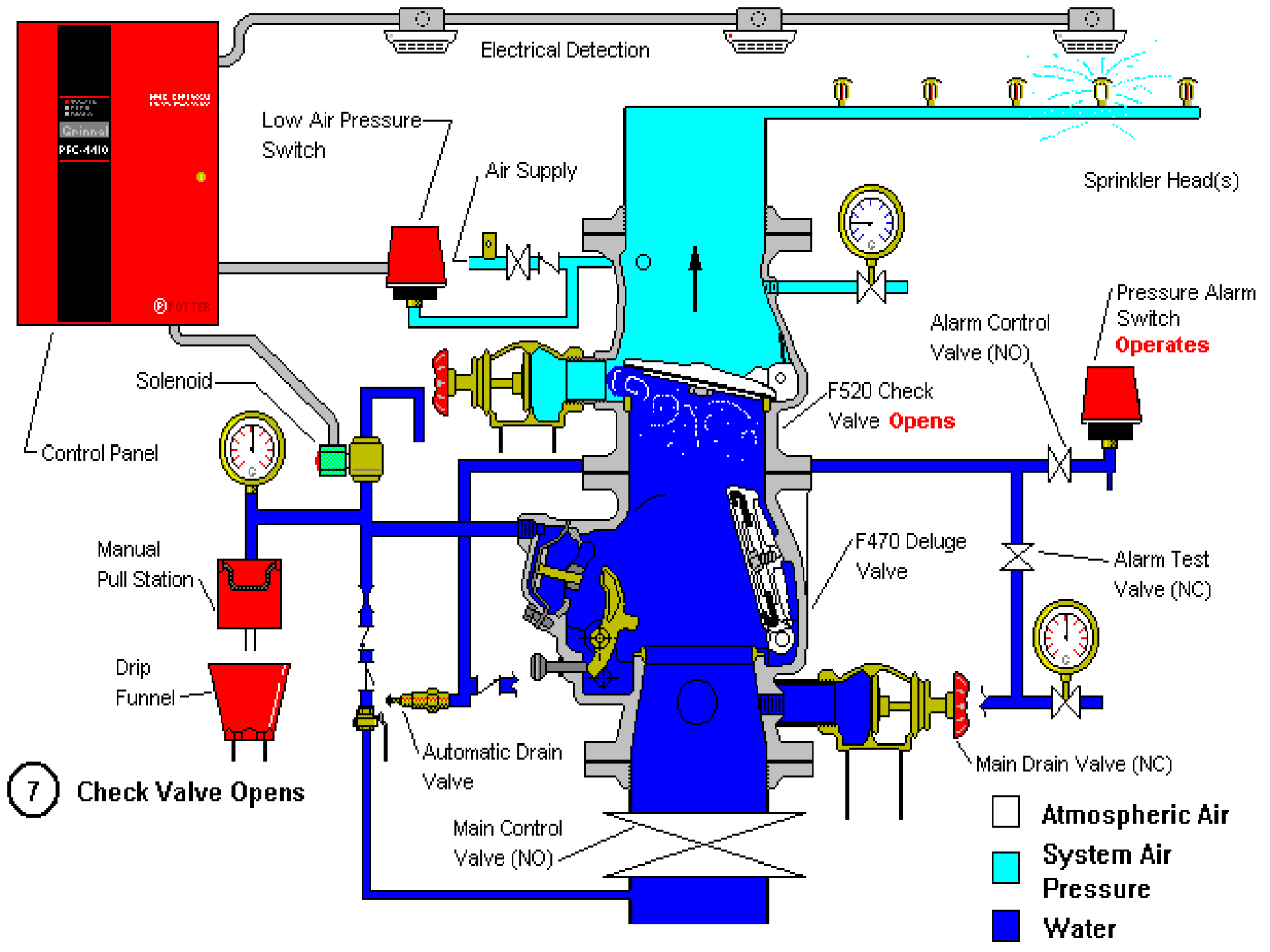

Signal Sent to Control Panel
Electrical Detection
Senses a Fire Condition
Low Air Pressure Switch
Air Supply
To Closed Sprinklers
Sprinkler Head(s)
Pressure Alarm Switch
Alarm Control Valve (NO)
Solenoid
F520 Check Valve
Control Panel
Initiates First Alarm
Manual Pull Station
F470 Deluge Valve
Alarm Test Valve (NC)
Drip Funnel
Automatic Drain Valve (NO)
Main Drain Valve (NC)
Main Control Valve (NO)
2 Signal Sent to Control Panel - First Alarm
Atmospheric Air
System Air Pressure
Water

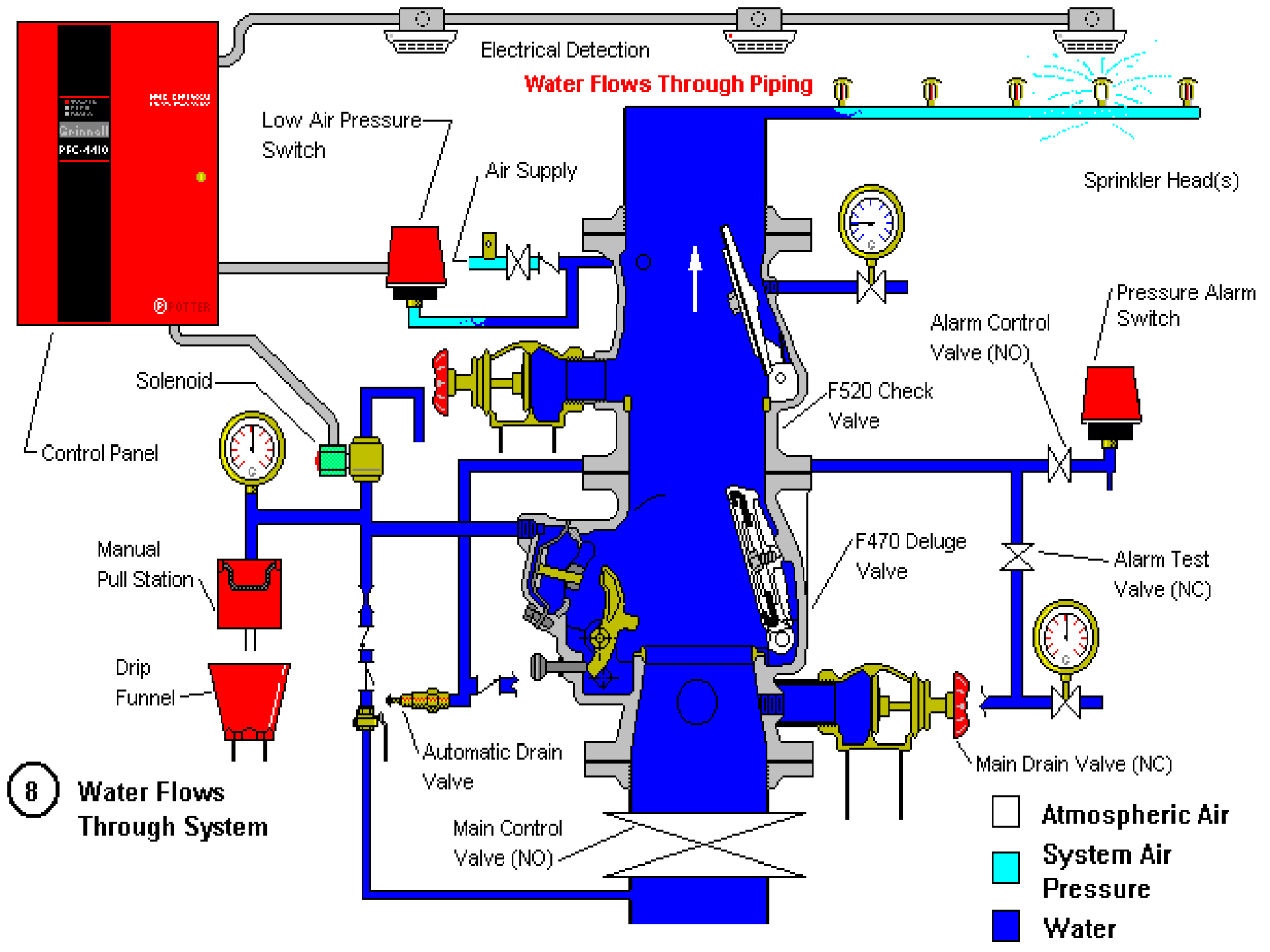

Electrical Detection
Low Air Pressure Switch
Air Supply
To Closed Sprinklers
Sprinkler Head(s) Operates
Pressure Alarm Switch
Alarm Control Valve (NO)
Solenoid
F520 Check Valve
Control Panel
Manual Pull Station
F470 Deluge Valve
Alarm Test Valve (NC)
Drip Funnel
Automatic Drain Valve (NO)
Main Drain Valve (NC)
Main Control Valve (NO)
3 Sprinkler Head Operates - Loss of Air Pressure
Atmospheric Air
System Air Pressure
Water


Electrical Detection
Low Air Pressure Switch Operates - Signal Sent to Control Panel
Air Supply
To Closed Sprinklers
Sprinkler Head(s)
Pressure Alarm Switch
Alarm Control Valve (NO)
Solenoid
F520 Check Valve
Control Panel Initiates Second Alarm
Manual Pull Station
F470 Deluge Valve
Alarm Test Valve (NC)
Drip Funnel
Automatic Drain Valve (NO)
Main Drain Valve (NC)
Main Control Valve (NO)
4 Low Air Pressure Switch Operates - Second Alarm
Atmospheric Air
System Air Pressure
Water

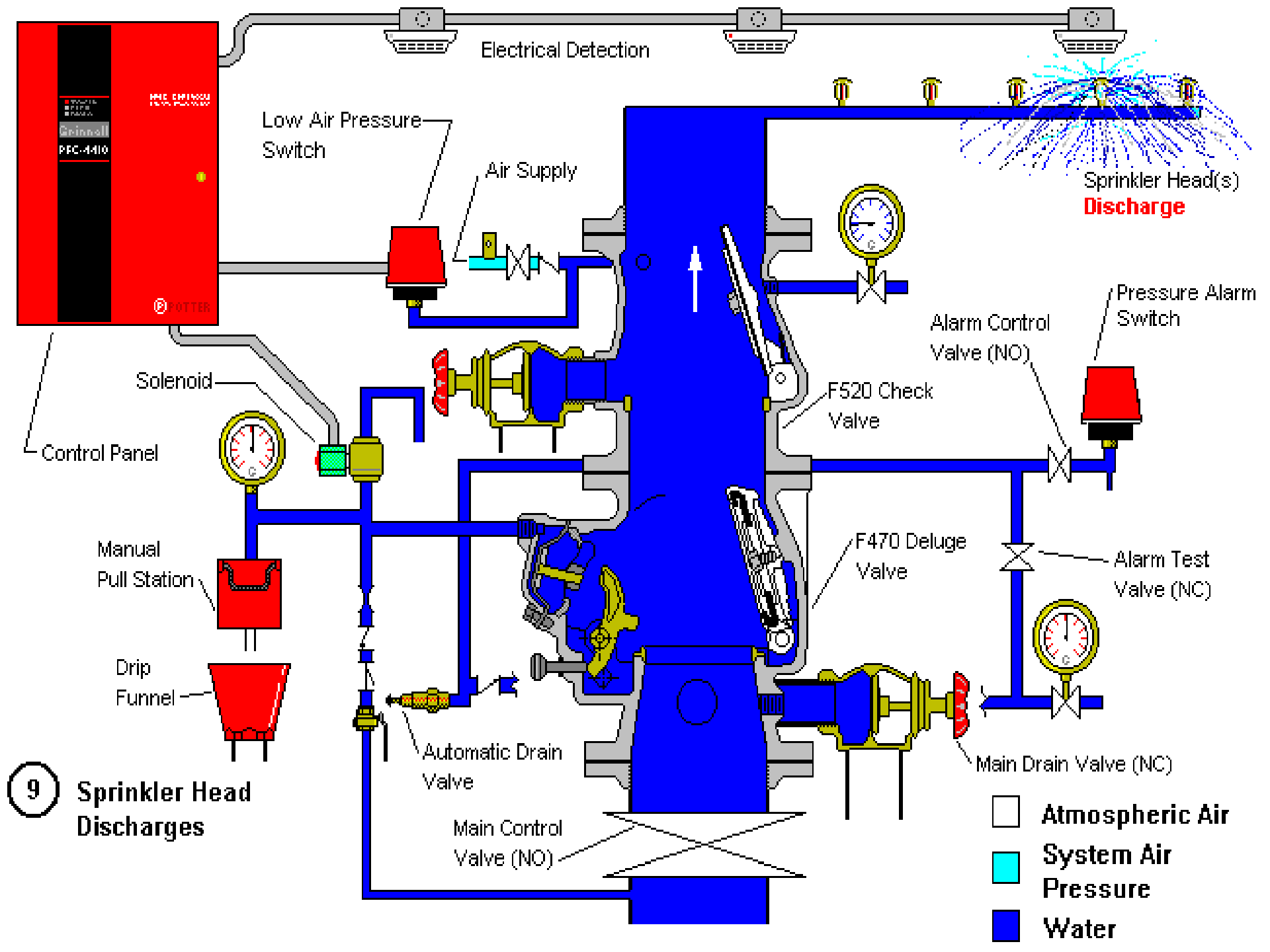

Electrical Detection
Low Air Pressure Switch
Air Supply
To Closed Sprinklers
Sprinkler Head(s)
Pressure Alarm Switch
Alarm Control Valve (NO)
F520 Check Valve
Solenoid Operates
Control Panel Sends Signal to Solenoid
Manual Pull Station
Drip Funnel
F470 Deluge Valve
Alarm Test Valve (NC)
Automatic Drain Valve (NO)
Main Drain Valve (NC)
Main Control Valve (NO)
5 Solenoid Operates
Atmospheric Air
System Air Pressure
Water


Electrical Detection
Low Air Pressure Switch
Air Supply
To Closed Sprinklers
Sprinkler Head(s)
Pressure Alarm Switch
Alarm Control Valve (NO)
Solenoid
F520 Check Valve
Control Panel
Manual Pull Station
F470 Deluge Valve Opens
Alarm Test Valve (NC)
Drip Funnel
Automatic Drain Valve Closes
Main Drain Valve (NC)
Main Control Valve (NO)
6 Valve Opens
Atmospheric Air
System Air Pressure
Water


Electrical Detection
Low Air Pressure Switch
Air Supply
Sprinkler Head(s)
Pressure Alarm Switch Operates
Alarm Control Valve (NO)
Solenoid
F520 Check Valve Opens
Control Panel
Manual Pull Station
F470 Deluge Valve
Alarm Test Valve (NC)
Drip Funnel
Automatic Drain Valve
Main Drain Valve (NC)
Main Control Valve (NO)
7 Check Valve Opens
Atmospheric Air
System Air Pressure
Water



8 **Water Flows Through System**


Electrical Detection
Low Air Pressure Switch
Air Supply
Sprinkler Head(s)
Discharge
Pressure Alarm Switch
Alarm Control Valve (NO)
Solenoid
F520 Check Valve
Control Panel
Manual Pull Station
F470 Deluge Valve
Alarm Test Valve (NC)
Drip Funnel
Automatic Drain Valve
Main Drain Valve (NC)
Main Control Valve (NO)
9
Sprinkler Head Discharges
Atmospheric Air
System Air Pressure
Water

Stop Valves (zoning valve)

- Shall be of the
  - gate valve type or
  - butterfly valve type (unless otherwise show in the project specification)
- Open and closed position should be visible to naked eye.
- Shall have
  - flanged ends (dia 100mm and above),
  - metal body
  - a rated for working pressure of 1.5 times system operating pressure **as a minimum.**

Water Flow Sensor

- Shall be UL listed or LPCB approved
- Shall be designed and installed to indicate activation of sprinkler zone
- Shall be interfaced via a module with the alarm control panel.

Pipes and Fitting

- All piping materials and accessories shall be galvanized steel to BSEN 10255 Class C ,BS 1387, ASTM Schedule 40
- Piping of any other specialized material such as cPVC , HDPE, PPR, if specified in project specification and accepted by AHJ shall conform to UL or LPCB or FM approved or relevant NFPA Standard or BSEN.
- cPVC only used for light hazard areas (see fire regulation for different hazard area)
- Joining methods:
  - 65mm and above welded/ grooved/ flanged
  - 50mm and below threaded
  - Any welding shall be cold galvanized

Pipes and Fitting *continued …*

- Grooved type pipe fittings

Pipes and Fitting *continued …*

- Flange type fittings & bolting shall comply to BS 2035 & BS 4504

Pipes and Fitting *continued …*

- Welding of sprinkler pipe work shall comply to BS 2640 or BS 2971
- Wieldable pipe fittings

Hangers & Supports

- Pipe hangers & supports shall comply with BSEN 13480 Part3

- The space between pipe supports shall vary according to
    - the bore of the pipe
    - the piping material
    - whether the pipe is running horizontal or vertical.

Distance Between Pipe Supports

Pipe Size (mm)	Horizontal pipe support spacing (mm)	Vertical pipe support spacing (mm)
15	1800	2400
20	2400	3000
25	2400	3000
32	2400	3700
40	2400	3700
50	2400	4600
65	3000	4600
80	3000	4600
100	3000	5500
125	3700	5500
150	4500	5500
200	6000	8500
250	6500	9000
300	7000	10000

Pipe Painting

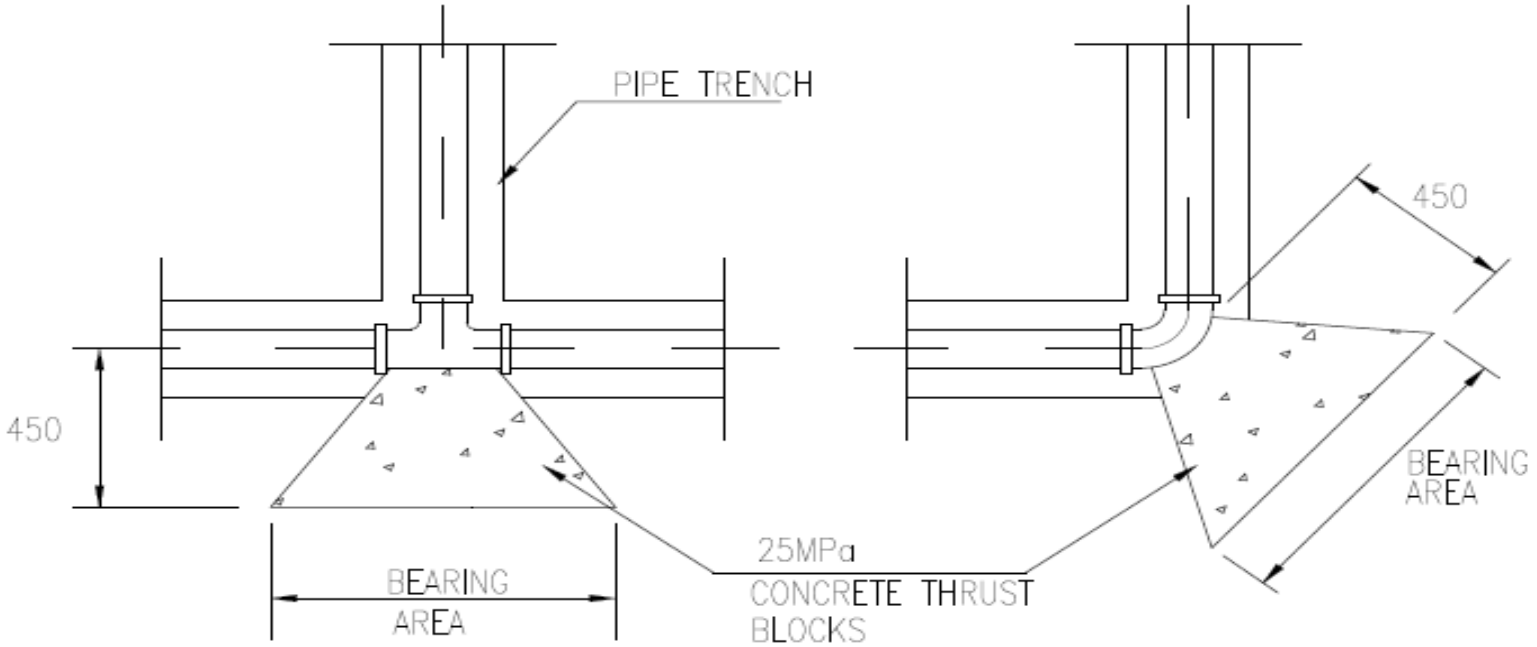
- The painting shall be
  - Zinc rich primer one coat
  - Minimum two coat of finishing (red color) unless otherwise specified in project specification
- Flow direction shall be indicated with an arrow

Underground Piping

- Piping materials and accessories shall be **seamless** galvanized steel to BSEN 10255(BS 1387)Class C , ASTM Schedule 40 or **HDPE**
- Same painting method shall apply
- Pipe shall be two layer of wrapping. Wrapping martials shall be approved by the engineer
- Pipe Depth, back filling & sand layer heights depends on soil condition, to be approved by the Engineer
- Concrete Hume pipes shall be used in road, heavy vehicle moving areas
- Concrete thrust block shall be used any pipe directional change
- Waning tape shall be laid just below the top most soil layer

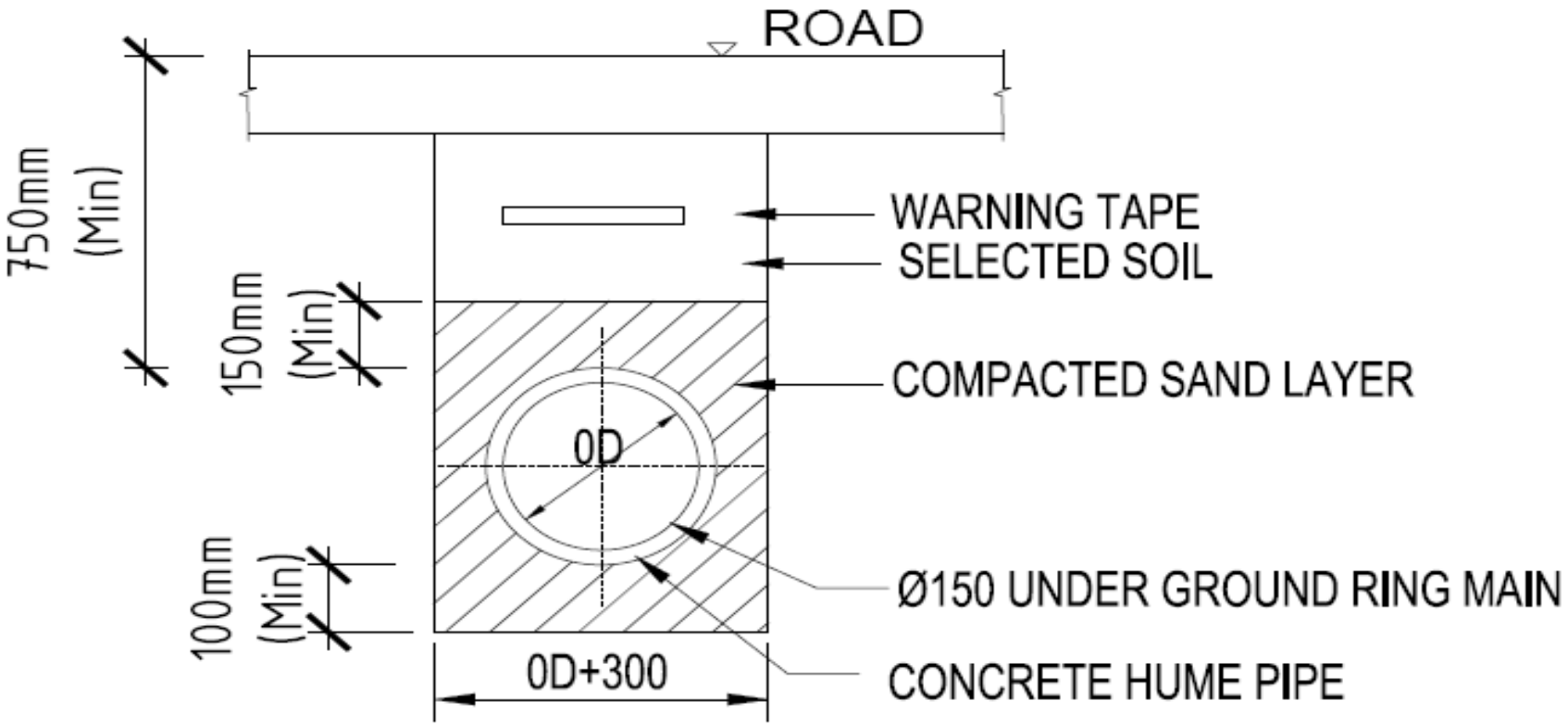
Underground Piping *continued …*

For the underground piping direction change



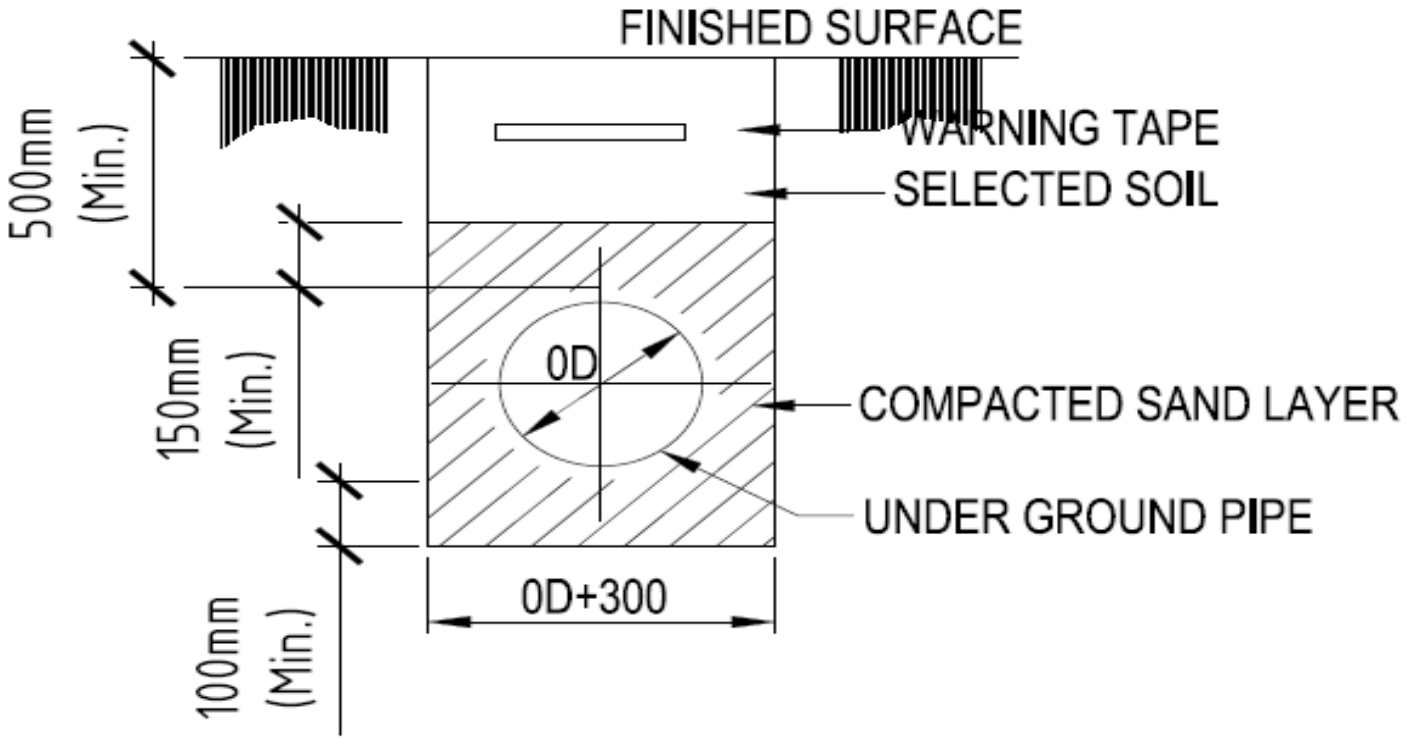
THRUST BLOCK DETAILS

Underground Piping *continued …*



PIPE WORK TRENCHING DETAIL IN ROAD CROSSING AREA

Underground Piping *continued …*



PIPE WORK TRENCHING DETAIL IN LANDSCAPED AREAS

Gas Suppression Systems

Gas Suppression Systems

- **What is an inert gas?**
  - Inert Gases are naturally occurring gases. These are not man made or fossil gases. Ex: Co_2,Ar, N_2
  - Inert gas use for fire suppression since early 1990

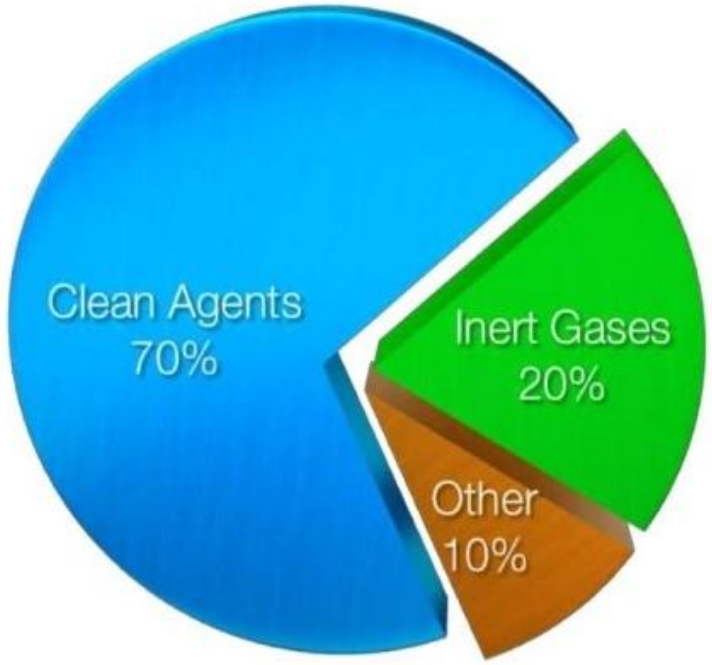
- **How do Inert Gases work as a fire suppression system?**
  - Fires need more than 15% Oxygen to combust. Anything below this level of oxygen will not be enough for a fire to sustain combustion. Luckily, human only need 12% plus of oxygen to survive
  - To extinguish a fire and sustain life, we need to reduce oxygen from 21% (assuming were at sea level) to below 15%, but not less than 12%. This will extinguish a fire and sustain life at the same time.

EXTINGUISHING AGENT

- **Oxygen-displacing extinguishing gases - inert gases and carbon dioxide (CO_2)**
  - Main Disadvantages
    - High Ozone Depleting Potential.
    - High Global Warming Potential
    - Atmospheric Lifetime over years
  - Therefore new innovated system required with following
    - Zero Ozone Depleting Potential.
    - Zero Global Warming Potential
    - Atmospheric Lifetime not exceeding one week.

Clean Agent – Chemical suppression system

- After 1995, chemical extinguishing system came to market
  - FE-13
  - FM-200 / Sinorix 227
  - Novec 1230 / Sinorix 1230
  - Water Mist



Clean Agents Vs Inert Gases

Clean Agents

- Manufactured by man
- Same family as refrigerants
- Super-pressurized with nitrogen to a liquid form
- Low-pressure
- Higher air density
- 10-second discharge

Inert Gases

- Naturally occurring
- Reduce concentration of oxygen
- Super-pressurized, but still in a gaseous form
- High-pressure
- Normal air density
- 60-second discharge

Key Benefits & Disadvantages

Trade Name	Stored Pressure	Safety Factor	GWP	Key Benefits	Key Disadvantages
FM-200	360 PSI	28%	2900	Most common, easy to obtain service, low pressure	Damage to environment
NOVEC-1230 or Sapphire	360 PSI	112%	1	Wide safety margin, good for environment, low pressure	Since 3M only introduced it in 2003, it is relatively new
Ecaro or FE-25	609 PSI	-22%	2800	Less agent required, may be a drop-in replacement for Halon	Dangerous to humans, may be outlawed again
FE-13	609 PSI	67%	11700	Very effective	Not typically used for occupied areas, not good for environment
Inergen	2900 PSI	10%	0	Good for environment, close to atmospheric density	60-second discharge time, 40% volume added to room, up to 10x as many cylinders
Argonite	2900 PSI	13%	0	Same as above and easier to refill than Inergen	Same as above and no 180 degree nozzles
Carbon Dioxide	2900 PSI	Lethal	0	Very effective, easy to refill	Not permitted for use in occupied areas

System operation

Gas stored in cylinders

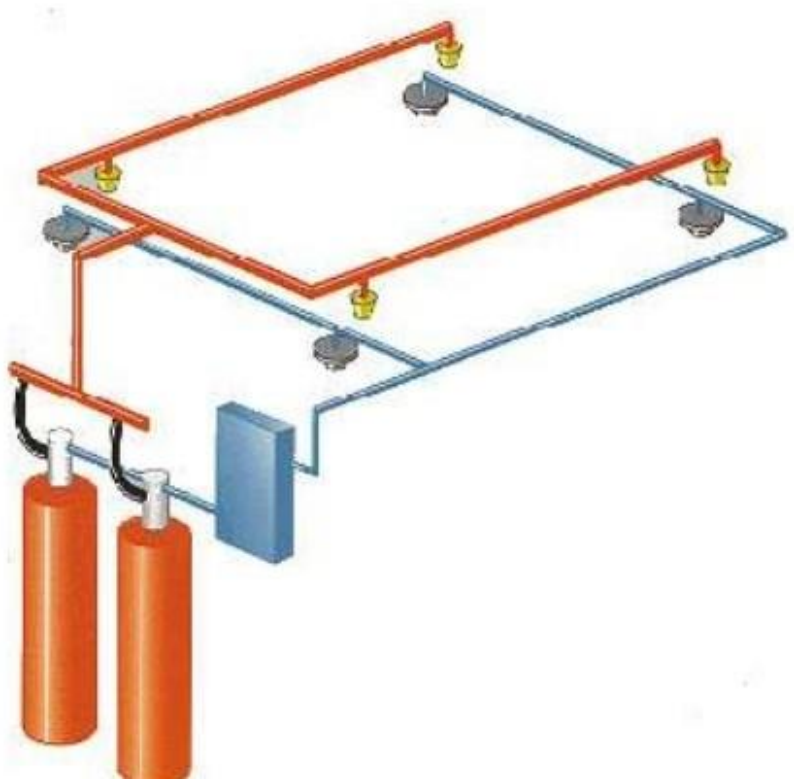
Pipe distribution system

Electronic actuation

Total flooding principle

Preaction detection

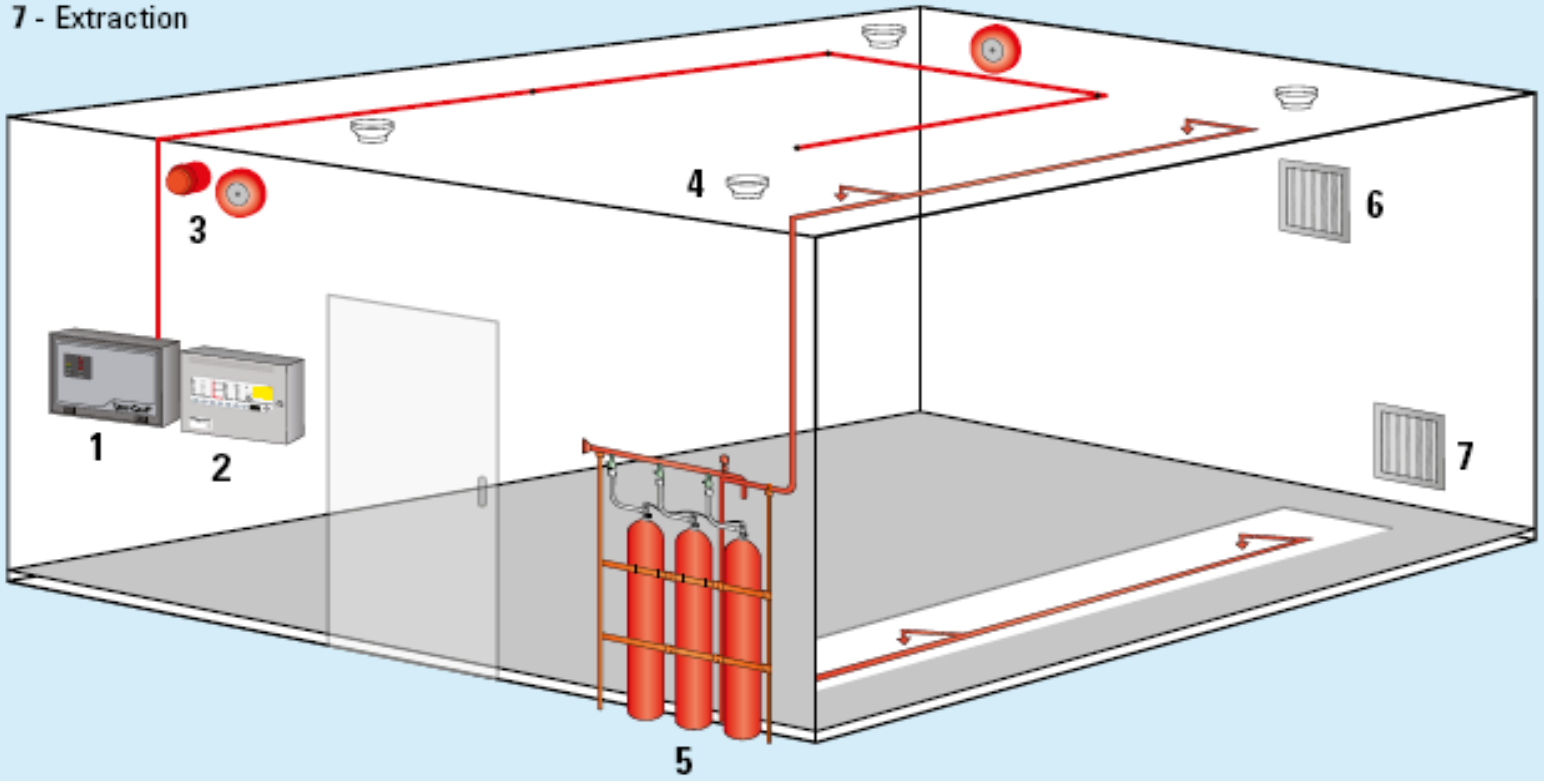
- Early warning
- 30-second countdown
- Optional abort



System operation continued …

Typical Fixed Gas Extinguishing Systems

1 - High Sensitivity Aspirating Fire Detection
2 - Suppression Control Panel
3 - 1st & 2nd Stage Alarm Sounders
4 - Smoke Detection
5 - Extinguishing Agent Storage Cylinders
6 - Pressure Relief
7 - Extraction



The properties of chemical and inert suppression agents used in total flood applications

	Inert Extinguishing Agents			Chemical Extinguishing Agents	
DESIGNATED NAME	IG-55	IG-01	IG-541	HFC-227ea	HFC-23
Trade name	Argonite	Argon	Inergen	FM-200/FE-227	FE-13
Type	Inert Gas	Inert Gas	Inert Gas	Halocarbon	Halocarbon
Ozone Depleting Substance	No	No	No	No	No
Greenhouse Effect	No	No	Yes	Yes	Yes
Design Concentration	38% - 41%	38% - 41%	38% - 41%	7.5%	16.5% - 18%
Extinguishing Mechanism	Reduction of Oxygen	Reduction of Oxygen	Reduction of Oxygen	Cooling at Molecular Level	Cooling at Molecular Level
Residual Oxygen Concentration	10% - 12%	10% - 12%	10% - 12%	20%	18%
No Observed Adverse Effect Level	43%	43%	43%	9%	50%
Lowest Observed Adverse Effect Level	52%	52%	52%	10.5%	>50%
Storage Pressure	Up to 300 bar	Up to 300 bar	Up to 300 bar	25 and 42 bar	42 bar
Cylinder Size (litres)	80	140	80	5 to 243	5 to 120
Discharge Time	60 Seconds	60 Seconds	60 Seconds	10 Seconds	10 Seconds
Pressure Relief Required	Yes	Yes	Yes	No	No
Location from Risk*	Up to 50m	Up to 50m	Up to 50m	Up to 10m	Up to 20m
Risk Volume:	No. of Cylinders (footprint)				
50m³	2 (0.23m²)	1 (0.17m²)	1 (0.23m²)	1 (0.12m²)	1 (0.16m²)
100m³	3 (0.36m²)	2 (0.4m²)	3 (0.34m²)	1 (0.12m²)	1 (0.16m²)
250m³	8 (0.98m²)	5 (0.89m²)	8 (0.91m²)	1 (0.16m²)	2 (0.44m²)
400m³	13 (1.51m²)	7 (1.22m²)	12 (1.27m²)	1 (0.32m²)	4 (0.78m²)
550m³	18 (1.95m²)	10 (1.71m²)	17 (1.9m²)	2 (0.65m²)	5 (0.94m²)
1,000m³	33 (4m²)	18 (3.09m²)	30 (3.7m²)	3 (0.97m²)	8 (1.43m²)

* Dependant on design configuration. Values are in accordance with the standard BS EN 15004 (2008).
All agents supplied by Protec Fire Detection plc are suitable for use in occupied areas.

Design Parameters

- The minimum criterion for the selection of the Clean Agent shall be on the following parameters
  - Zero Ozone Depleting Potential.
  - Zero Global Warming Potential
  - Atmospheric Lifetime not exceeding one week.

Design Parameters continues…

System requirements

- The clean agent fire extinguishing system shall perform as outlined in the following sub-sections.
  - » Achieve a 37.9% (v/v) extinguishing agent concentration.
  - » Within 60 seconds, the clean agent fire extinguishing system shall discharge 95% of the required suppression agent mass.
  - » The clean agent fire extinguishing system shall consist of one or more cylinders and related equipment. The cylinders may be either connected to a discharge pipe arrangement separately or connected to a common manifold and discharge pipe arrangement.
  - » The agent cylinders shall be filled and tested at specialist manufacturers works.

Design Parameters continues…

- Flow calculation reports
  - The specialist manufacturer shall calculate system requirements using UL listed software and shall provide the following information in the calculation report.
    - Hazard information with minimum design concentration, minimum enclosure ambient temperature, maximum enclosure ambient temperature
    - Cylinder information with capacity, stored pressure and quantity of cylinders
    - Pipe type, pipe diameter, pipe length, change in elevation, pipe equivalent length and any added accessory equivalent length.
    - Number of nozzles and identification of enclosure location, flow rate of associated nozzle, nozzle nominal pipe size, nozzle type and nozzle orifice area.
    - A detailed list of pipe, by schedule, nominal diameter and length, and fittings, by Class Rating, nominal diameter and quantity.
    - A calculation for each directional valve in the piping network.

Design Parameters continues…

- Pipes and Fittings
  - Distribution piping, and fittings, shall be installed in accordance with BS/NFPA, approved piping standards and the engineered fire suppression system manufacturer's requirements.
- Nozzles
  - Clean agent extinguishing system nozzles shall be made of brass.
  - Each nozzle shall be located in the space as per the manufacturer's guidelines. Nozzles shall have a 360-degree discharge pattern unless stated otherwise in project specification.
    - » Nozzles shall be selected for the a maximum ceiling height as per specific project requirement.
    - » Area coverage by each nozzle shall not be less than $100m^2$.
    - » Nozzles shall be rated for a minimum of 30.6 bar gauge nozzle pressure.

Foam Systems

Foam Systems

- **FOAM:**
  - A fire fighting foam is simply a stable mass of small air-filled bubbles, which have a lower density than oil, gasoline or water.
  - Foam is made up of three ingredients - water, foam concentrate and air. When mixed in the correct proportions, these three ingredients form a homogeneous foam blanket.
- **FOAM SOLUTION:**
  - This is a solution of water and foam concentrate after they have been mixed together in the correct proportions.
- **FOAM CONCENTRATE:**
  - This liquid concentrate is supplied from the manufacturer which when mixed with water in the correct proportion forms a foam solution.
- **DRAINAGE RATE:**
  - This is the rate at which the foam solution will drain from the expanded foam mass or how long it will take for 25% of the solution to drain from the foam. This is often called the quarter life or 25% drain time. Foam that has a fast drain time is normally very fluid and mobile, spreading across the fuel surface very quickly. While foams with longer drain times are normally less mobile, they move across the fuel surface slowly.

Foam Systems *continued ..*

- **EXPANSION RATE:**
  - Volume of finished foam divided by the volume of foam solution used to create the finished foam; i.e., a ratio of 5 to 1 would mean that one gallon of foam solution after aeration would fill an empty 5-gallon container with the expanded foam mass.
- **LOW EXPANSION FOAM:** Foam aerated to an expansion ratio of between 2 to 1 and 20 to 1.
- **MEDIUM EXPANSION FOAM:** Expansion ratio between 20 to 1 and 200 to 1.
- **HIGH EXPANSION FOAM:** Expansion ratio above 200 to 1.
- **DILUTION RATE, MIXING RATE, OR PROPORTIONING RATE (correct amount of foam concentrate to be mixed with water):**
  - The amount is normally shown on the pail or drum of concentrate. The container will normally display a figure or combination of figures. Normal figures shown are 1%, 2%, 3% or 6% or a combination of 1% and 3%, 3% and 3%, or 3% and 6%. If the container of foam concentrate has 3% shown, it means that for every 100 gallons of foam solution required, 3 gallons of the foam concentrate must be used in the solution with the balance being 97 gallons of water.
  - If 6% were displayed, this would mean that 6 gallons of the foam concentrate would be required to be mixed with 94 gallons of water to form the 100 gallons of foam solution. From the above, it becomes obvious that a 3% foam concentrate is twice as concentrated as a 6% foam concentrate. On the same size and type of flammable liquid fire, half as much 3% foam concentrate would be required than if the 6% foam concentrate had been used.

Foam Systems *continued ..*

- Shall be used in below ground level Oil risk situated area
  - Oil fired boiler room
  - Oil storage tank
  - Generator & fuel storage
  - Transformer chamber where may not be directly accessible for fire fitting operations

Foam Systems *continued ..*

- Capability of inlets and pipe lines
  - Fire authority should consulted on this matter
  - The delivery pipe length from each form inlet to the space protected should not exceed 18m
  - Pipe diameter 65mm/80mm as per the local authority requirement

Foam Systems *continued ..*

- Termination of Delivery pipes
  - In oil fired boiler room : 1m above from the level of oil burners
  - In oil storage tank chamber : 150mm above from the top level of the tank
  - In transformer chamber : at celling level

Thank you