2. Fire Services Part 2

2.1 Fire services systems

Ir Dr. Sam C. M. Hui
Department of Mechanical Engineering
The University of Hong Kong
E-mail: cmhui@hku.hk

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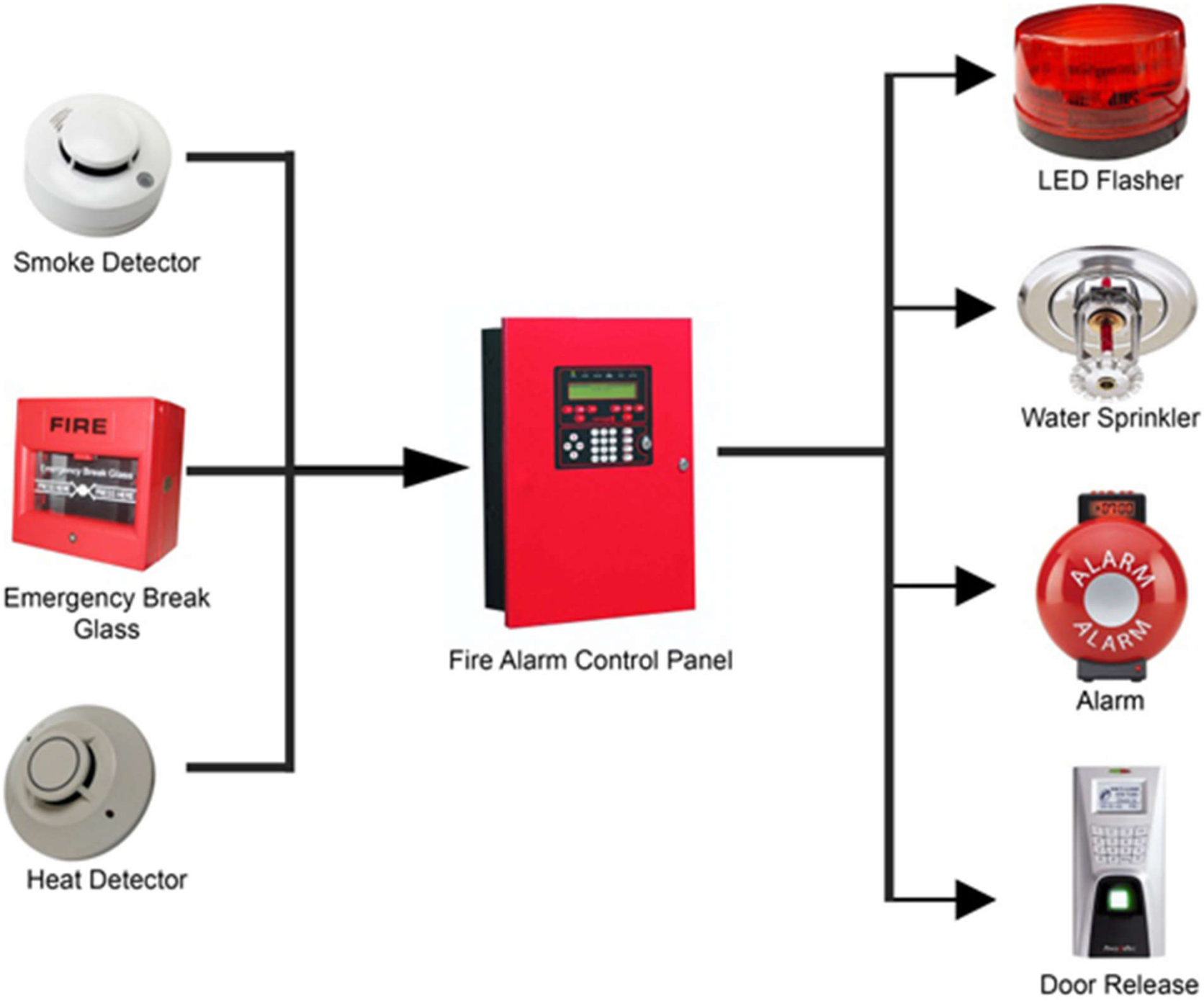
- Fire detection and alarm
- Automatic sprinkler system
- Fire hydrant/hose reel system
- Smoke management & control

Fire detection and alarm

- For early warning of a fire situation
- Classification of fire alarm systems
  - Household systems
  - Systems for property protection
  - Systems for life protection
  - Supervising station fire alarms (e.g. in campus)
  - Manual fire alarm systems
- Related standards: BS 5839 & NFPA 72

Automatic fire alarm and detection system



[Source: https://www.warwickshire.gov.uk/firealarmsystems]

Fire detection and alarm

- System components:
  - Fire alarm control unit/panel
  - Power supply (primary & secondary/backup)
  - Initiating devices (detectors, manual call points)
  - Notification devices (audible, visual)
  - Auxiliary devices
    - Smoke & ventilation controls (fire dampers or doors)
    - Door release (unlock doors along the path of egress)
    - Lift/elevator recall
    - Smoke vents & fire suppression systems

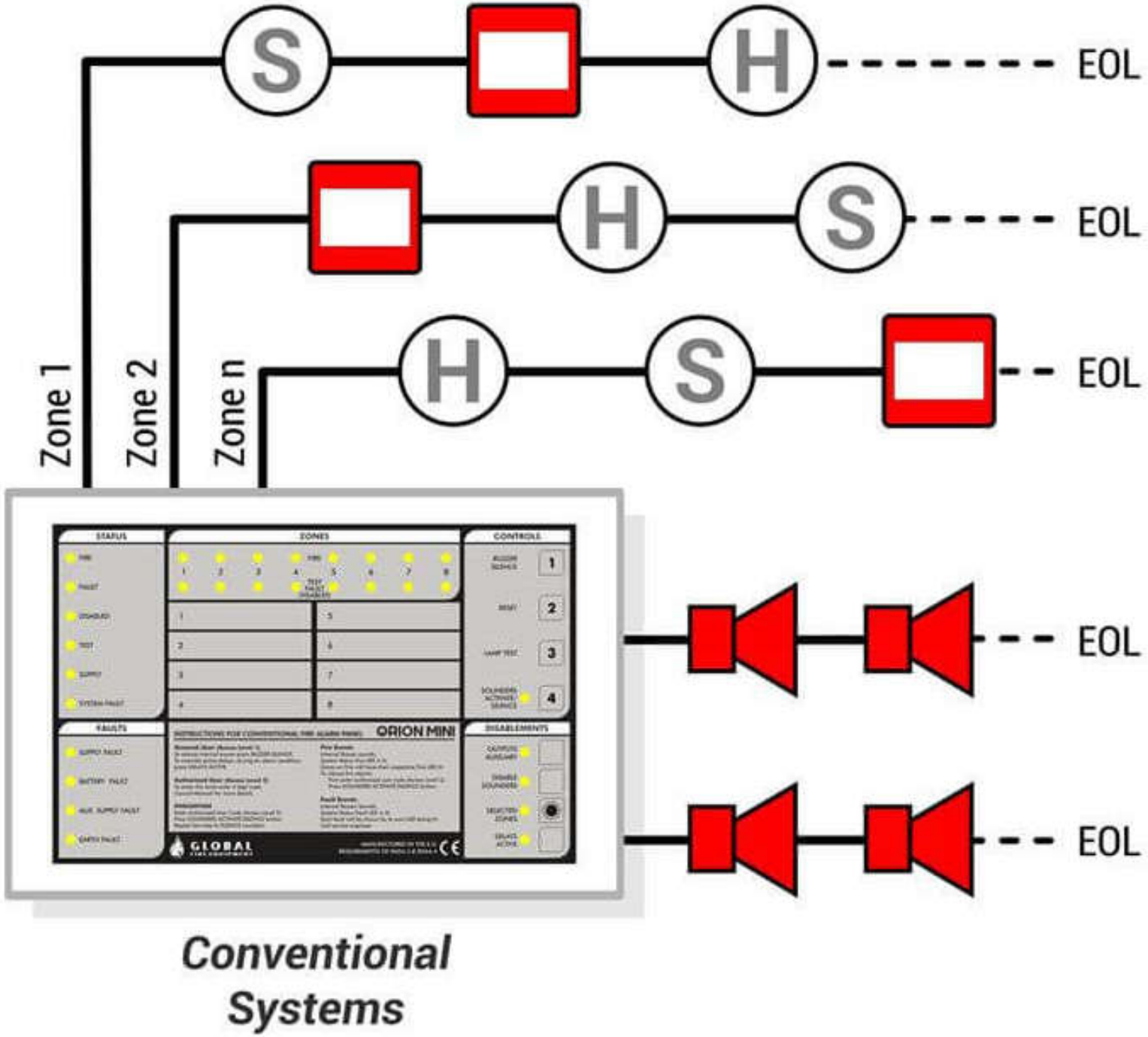
Fire detection and alarm

- Types of fire detection systems
  - Conventional monitored
  - Analogue/Addressable (with loop)
  - Intelligent (each detector has a microprocessor)
  - Wireless (no need for cabling)

- Video: What is a Fire Alarm System? (11:05)

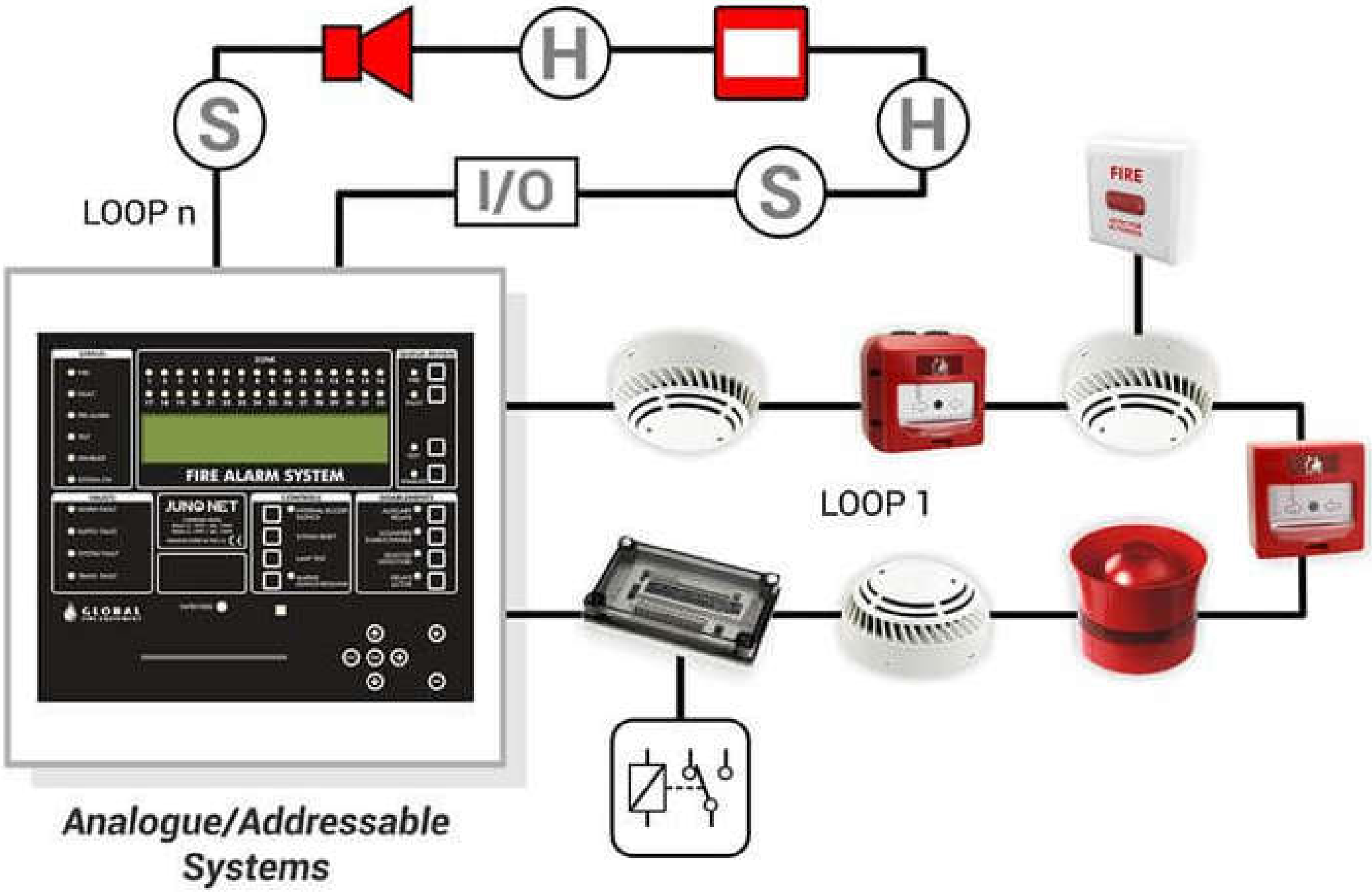
https://youtu.be/cVjyDgFrb2g

Fire detection system: conventional monitored



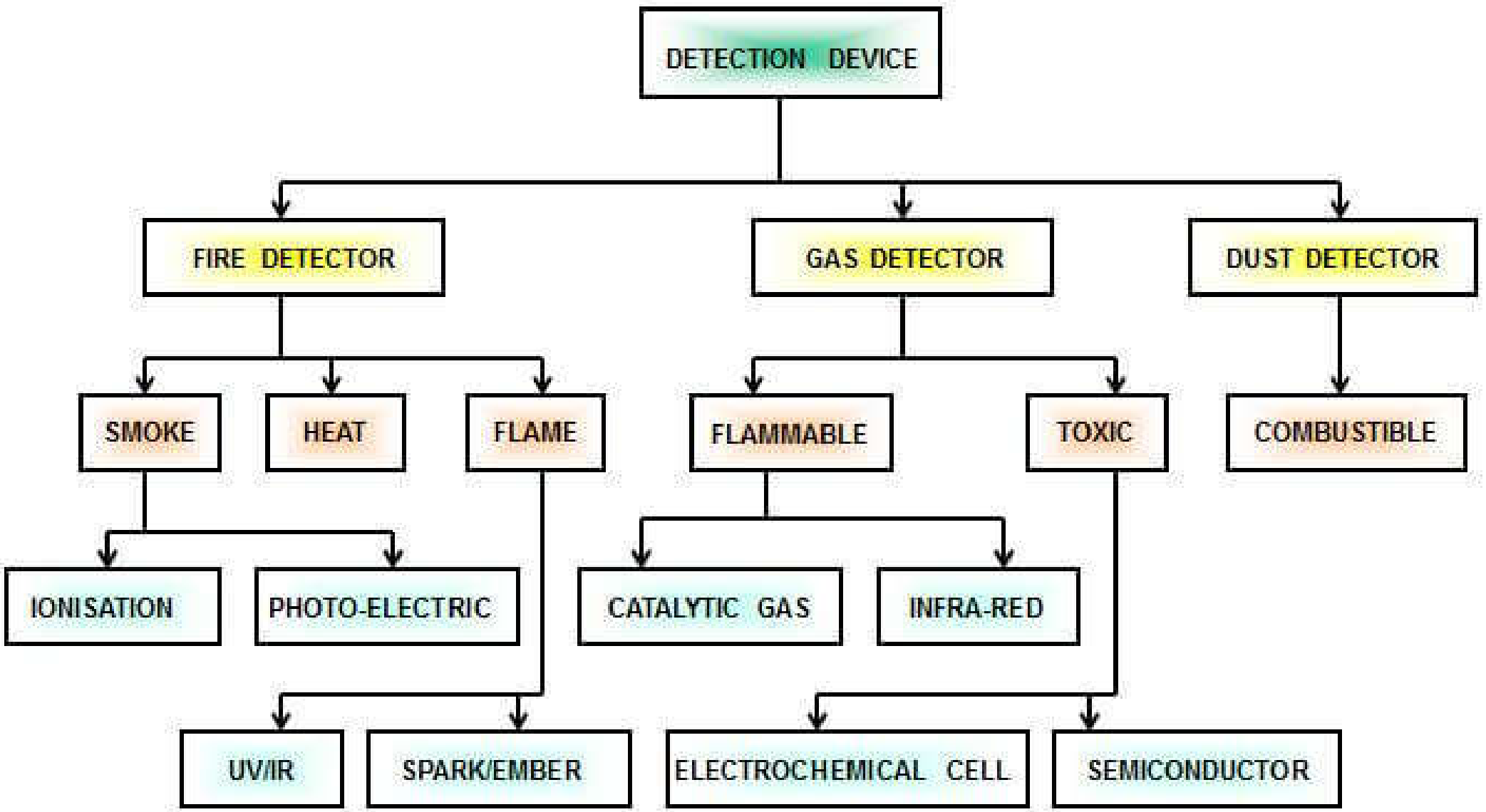
[Source: https://www.firesafetysearch.com/automatic-fire-detection-systems-conventional-addressable/]

Fire detection system: analogue/addressable



[Source: https://www.firesafetysearch.com/automatic-fire-detection-systems-conventional-addressable/]

Types of fire and gas detectors



[Source: https://instrumentationtools.com/types-of-fire-and-gas-detectors/]

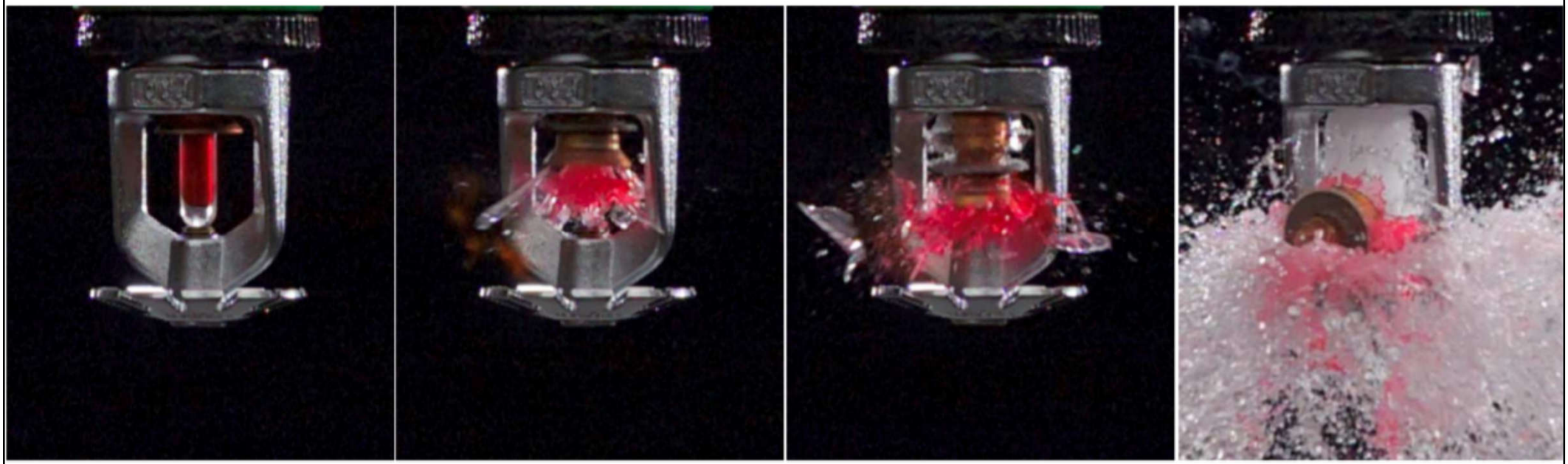
Fire detection and alarm

- Automatic initiating devices (detectors)
  - Fixed-temperature heat detectors
  - Rate-of-rise heat detectors
  - Smoke detectors
  - Flame detectors
  - Combination detectors
  - Sprinkler waterflow alarm-initiating devices

Automatic sprinkler system

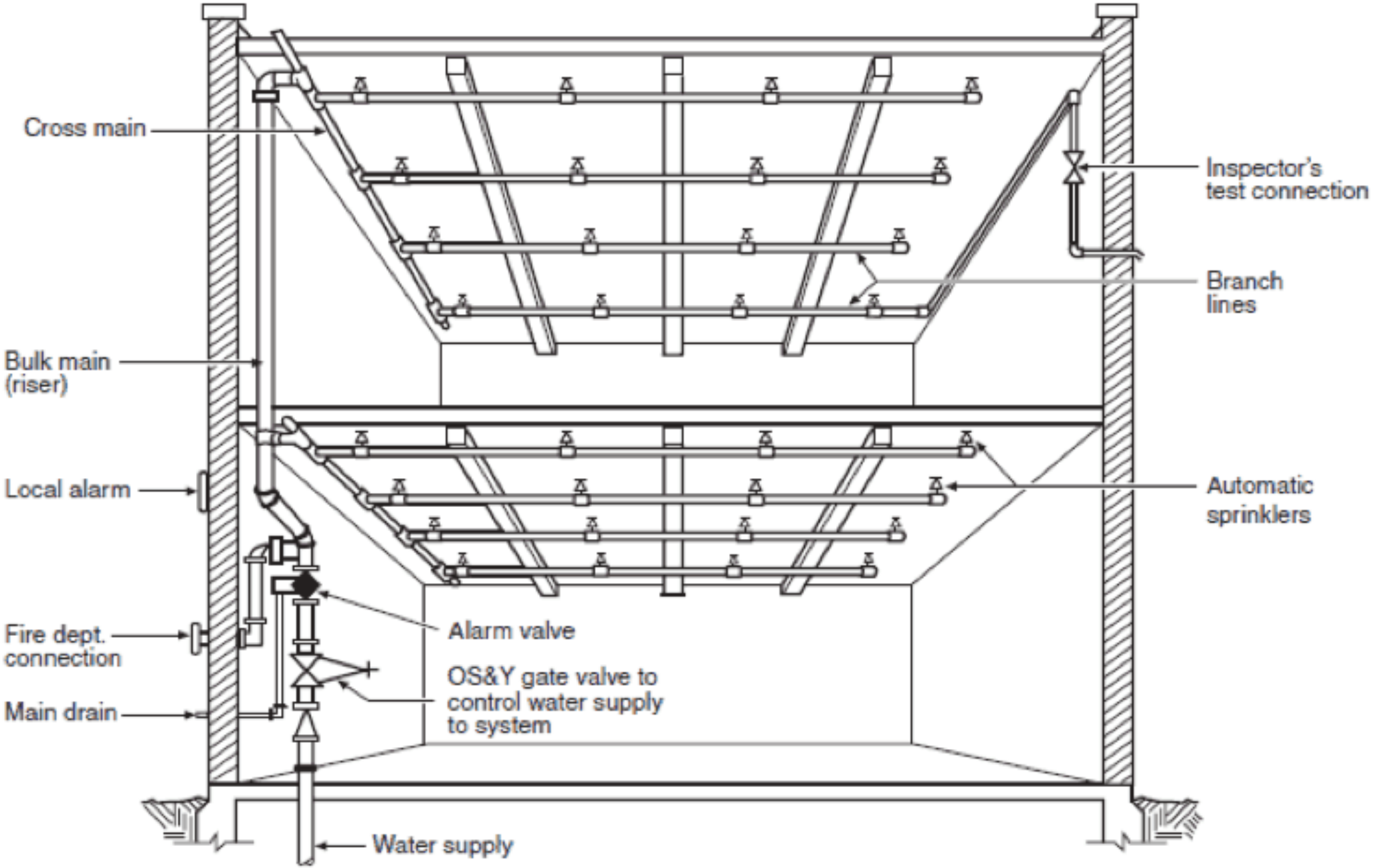
- It is designed to detect a fire and extinguish it with water in its early stages or hold the fire in check so that extinguishment can be completed by other means
  - DETECT the presence of a fire (acting like a heat detector)
  - FIGHT / CONTROL the fire (by the use of water spray)
- Related standard & practice:
  - Loss Prevention Council (LPC) Rules for Automatic Sprinkler Installations incorporating BS EN12845
  - Local practice in HK
    - High rise sprinkler systems
    - Addition of intermediate booster pump

Fire sprinkler systems



[Image source: http://jpfire.co.uk/]

An example of sprinkler system

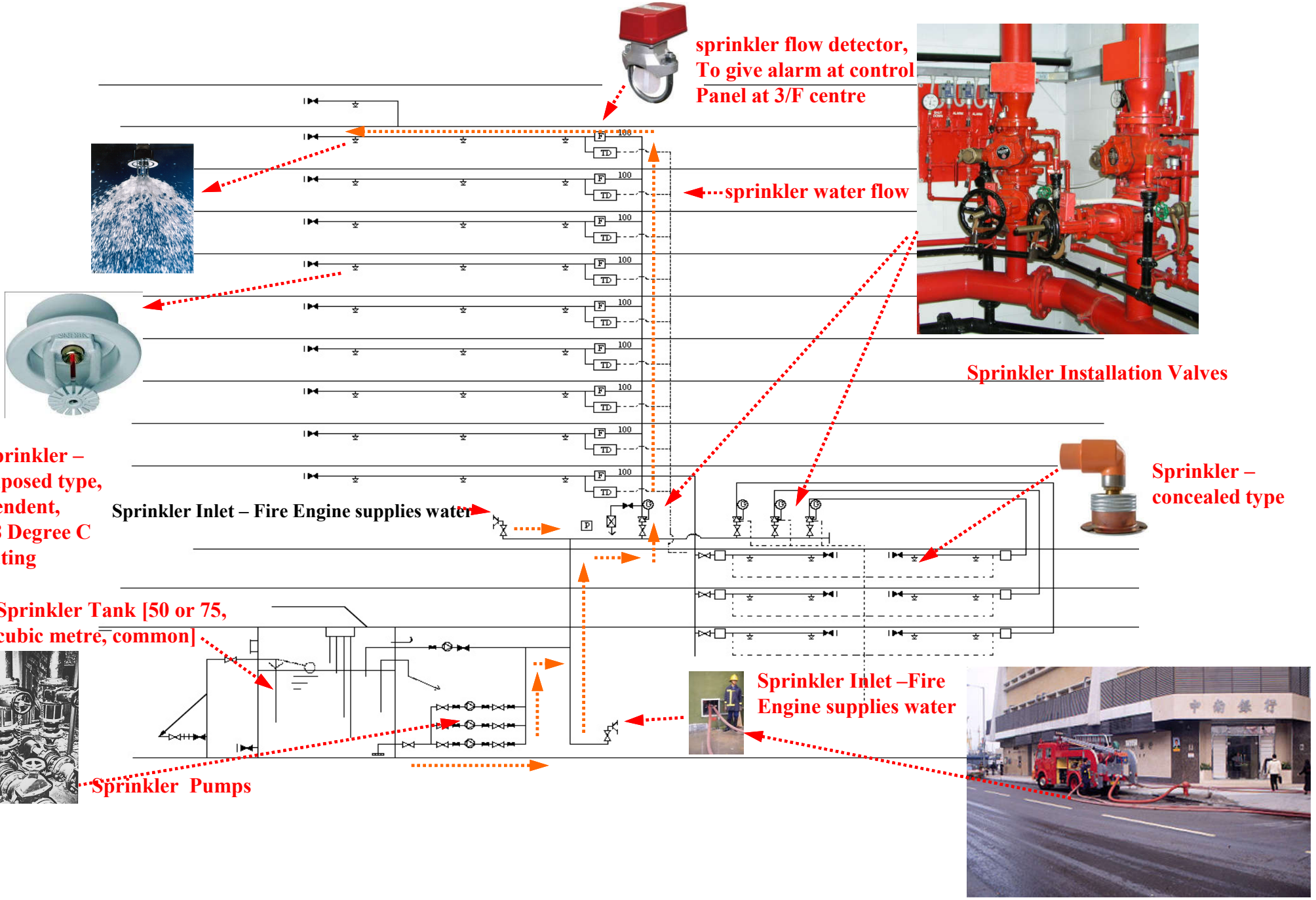


[Source: https://www.stoppieng.com/when-are-fire-sprinkler-systems-required-for-new-construction/]

Automatic sprinkler system

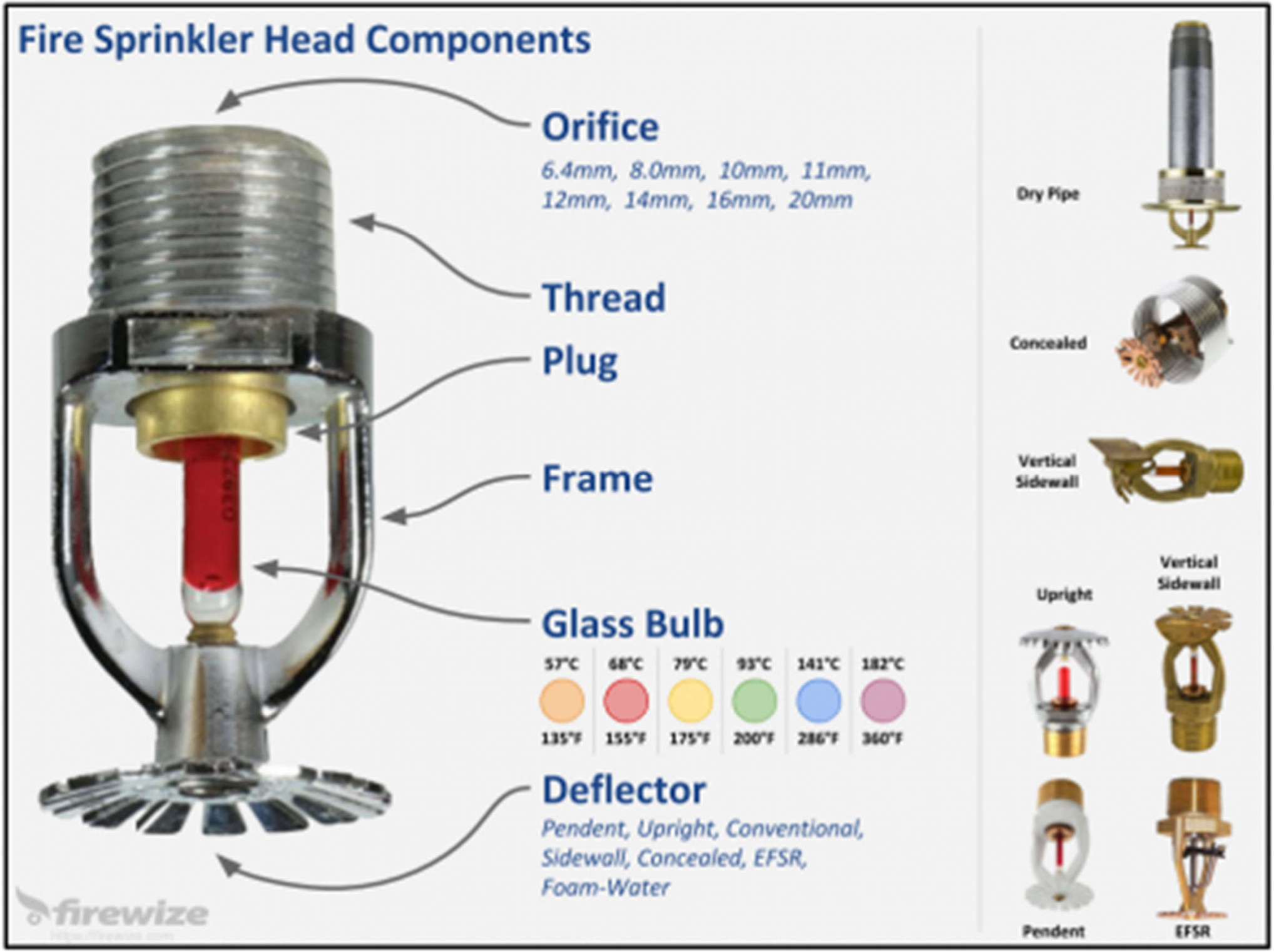
- A sprinkler system consists of a water supply (or supplies) and one or more sprinkler installations
  - Each installation consists of a set of installation main control valves & a pipe array fitted with sprinkler heads
- The sprinkler heads are fitted at specified locations at the roof or ceiling, and where necessary between racks, below shelves, and in ovens or stoves

Schematic diagram & components of an automatic sprinkler system



[Source: Ir K. P. Cheung]

Pipe fittings of sprinkler system



[Source: https://firewize.com/learn/principle/sprinkler/sprinkler_head]

Automatic sprinkler system

- Types of sprinkler systems
  - 1. Wet system (water inside pipeline & under pressure at all times)
  - 2. Dry system (pipeline contains compressed air or inert gas under pressure)
  - 3. Alternative wet and dry pipe system
  - 4. Pre-action system (a dry system activated by detectors)
    - Single interlock, double interlock, re-cycling
  - 5. Deluge system (use open-type sprinklers)

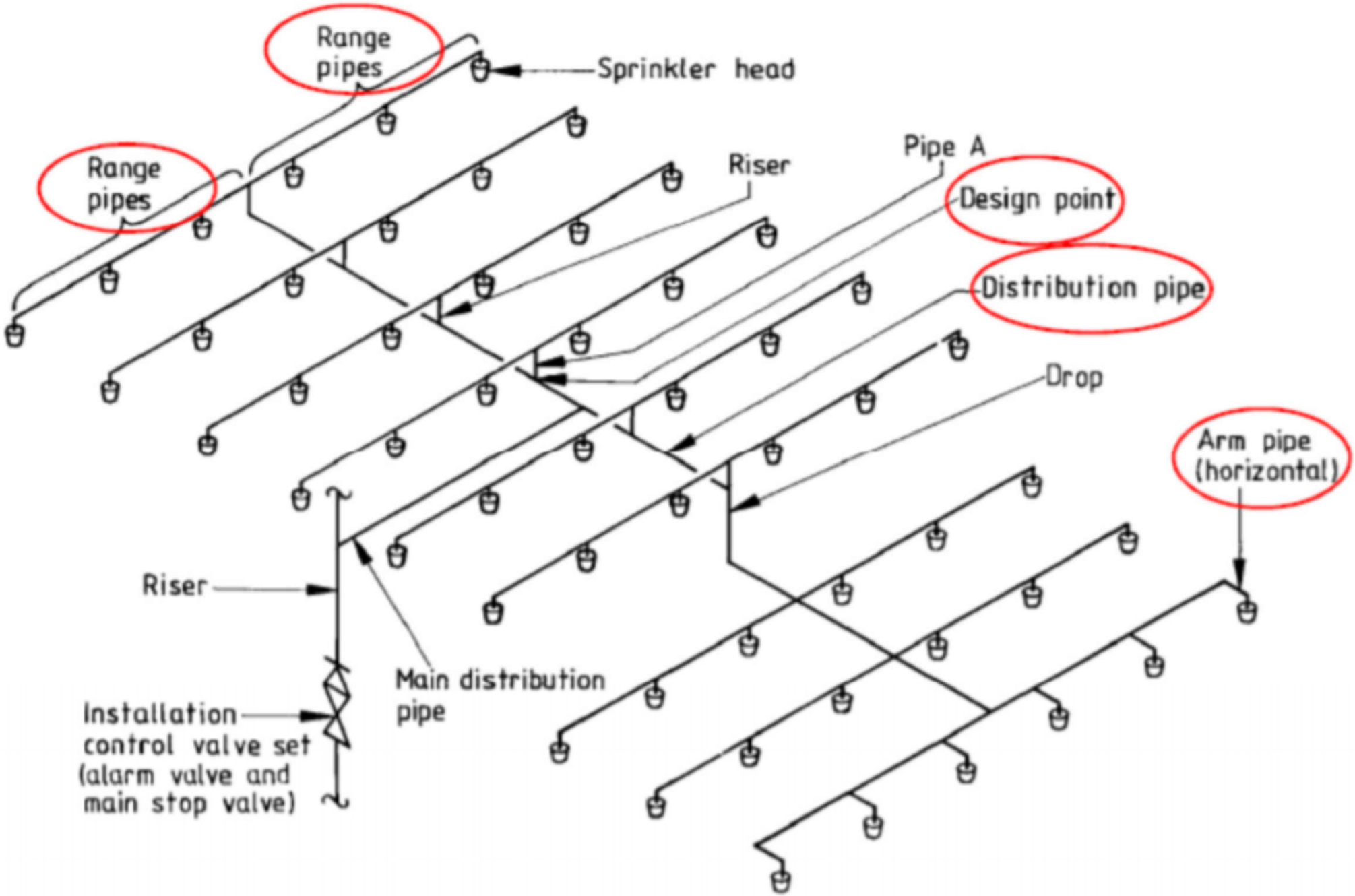
Automatic sprinkler system

- Classification of occupancies & fire hazards
  - Light hazard (LH)
  - Ordinary hazard (OH)
    - Subdivided into Group I, II, III and III Special
  - High hazard (HH)
    - Subdivided in accordance with process risk and high pile storage risk

Automatic sprinkler system

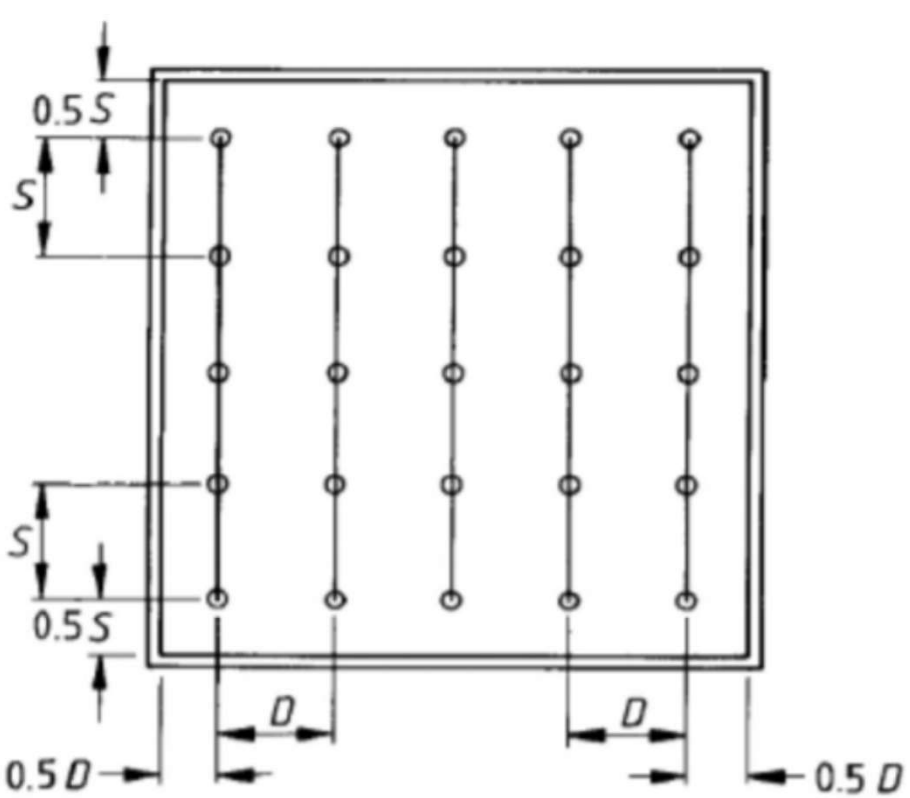
- Design of sprinkler installation
  - Suction pipe (water tank outlet pipe)
    - LPC Rules page 69 Table 30
  - Orifice of sprinkler head
    - LPC Rules page 115 Table 66
  - Flow rate and pressure of sprinkler pump
    - LPC Rules page 65 Table 28
  - Pipe sizing
    - Pre- calculated for general building
    - Full hydraulic calculation for high hazard projects

Main elements of a sprinkler installation

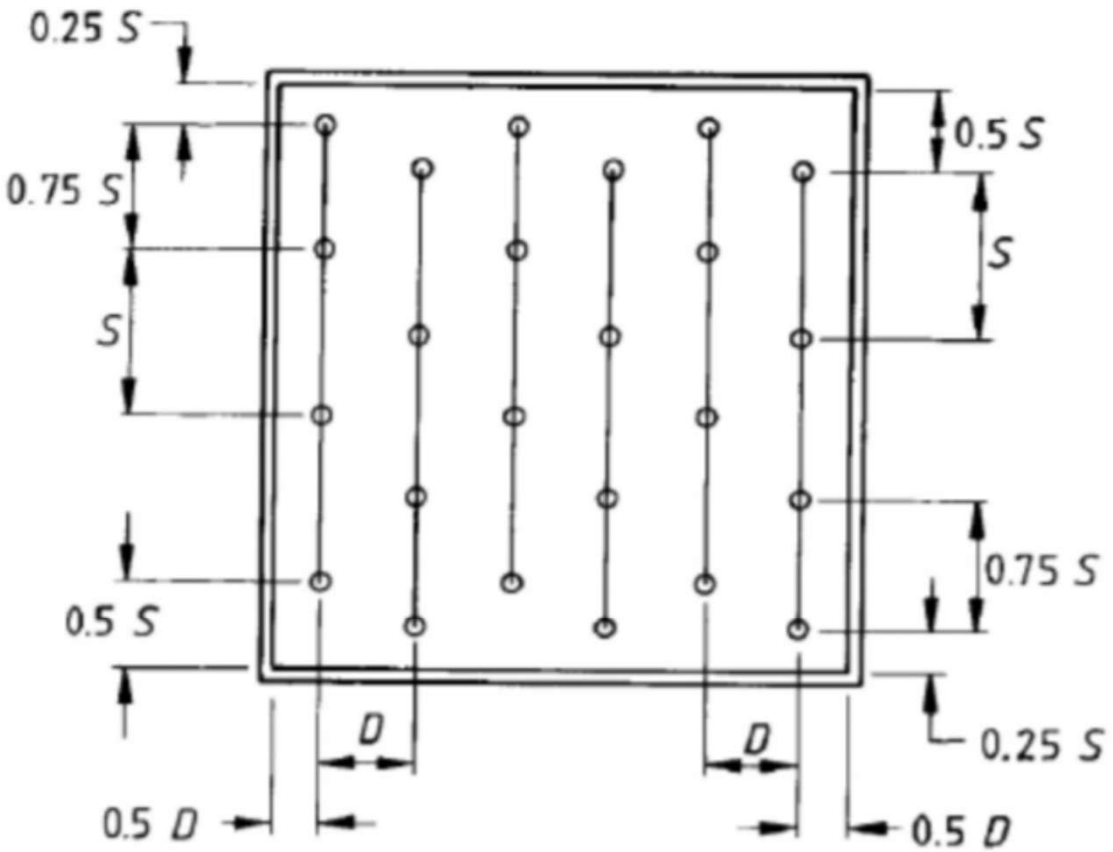


[Source: LPC Rules]

Sprinkler layout



Standard Layout



Staged Layout

[Source: LPC Rules]

Automatic sprinkler system

- Other requirements for sprinkler system design
  - Double layer sprinkler heads is required if space of false ceiling void exceeded 800 mm
  - Fast response sprinklers are to be used in following areas:
    - (a) Staircase from podium floor to residential floor
    - (b) Basement or floor below ground floor level
    - (c) Concealed type sprinkler head
  - Max. distance below measuring point from roof or ceiling to sprinkler head
    - (a) Distance is 450mm, if the construction of ceiling is combustible and their thickness is not less than 75 mm
    - (b) Distance is 150mm, if the construction of ceiling is non-combustible

Installing locations of sprinkler heads

Temperature Rating	Color of Bulb	Installing
57°C	Orange	Refuse Duct
68°C	Red	General use
79°C	Yellow	Kitchen Area
93°C	Green	Hood
141°C	Blue	Boiler Room
182°C	Mauve	Steel Manufactory
227 / 288°C	Black	Steel Manufactory

Fire hydrant/hose reel system

- Requirement of fire hydrant/hose reel (FH/HR) system in CoP-FSI (Hong Kong)
  - Section 5.14 Fire Hydrant / Hose Reel System
  - Section 5.25 Street Fire Hydrant System
  - Section 5.26 Supply Tank
  - Section 5.30 Water Supply

Fire hydrant/hose reel system

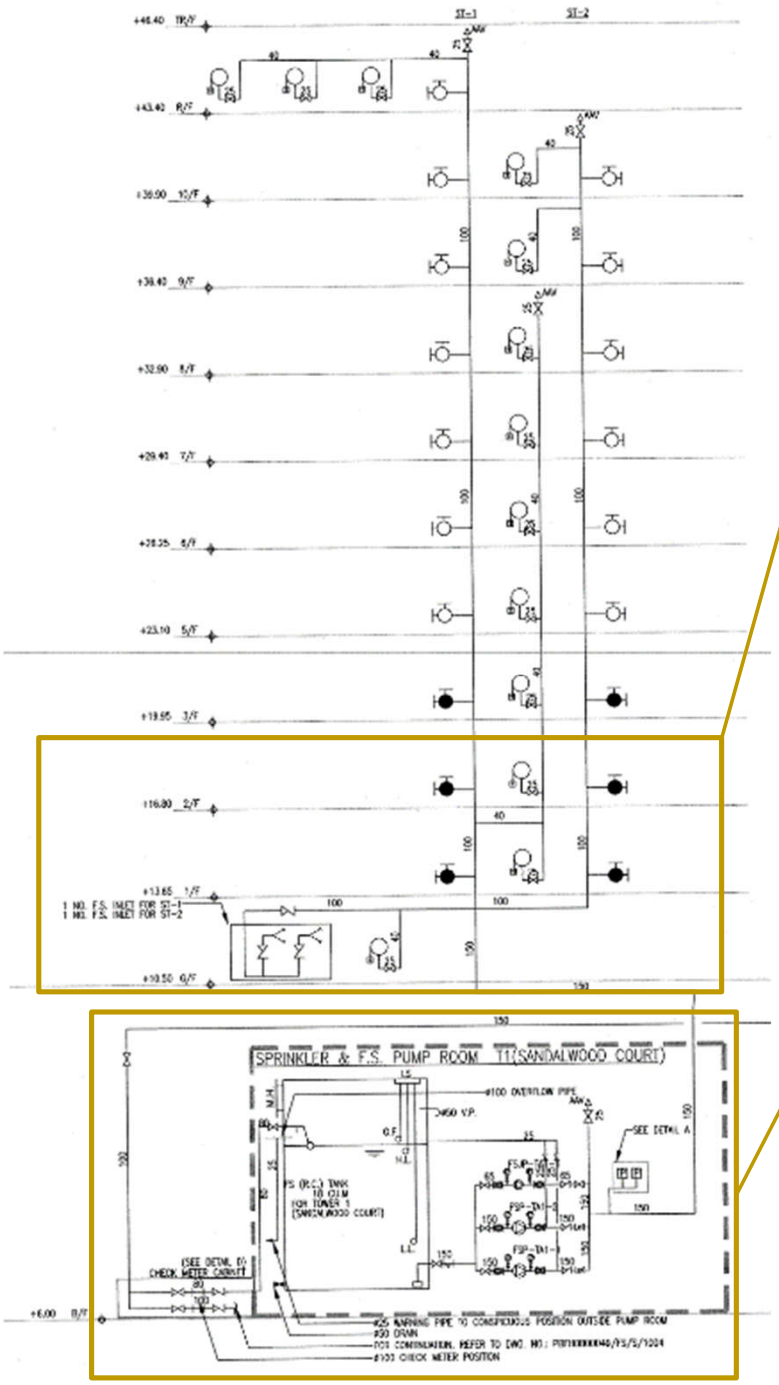
- Equipment of FH/HR in Hong Kong
  - (a) Fixed fire pump (FS pump)
  - (b) Intermediate booster pump
  - (c) Transfer pump (sump pump)
  - (d) Fire hydrant
  - (e) Hose reel
  - (f) Fire service inlet
  - (g) Fire service tank
  - (h) Fire service transfer tank

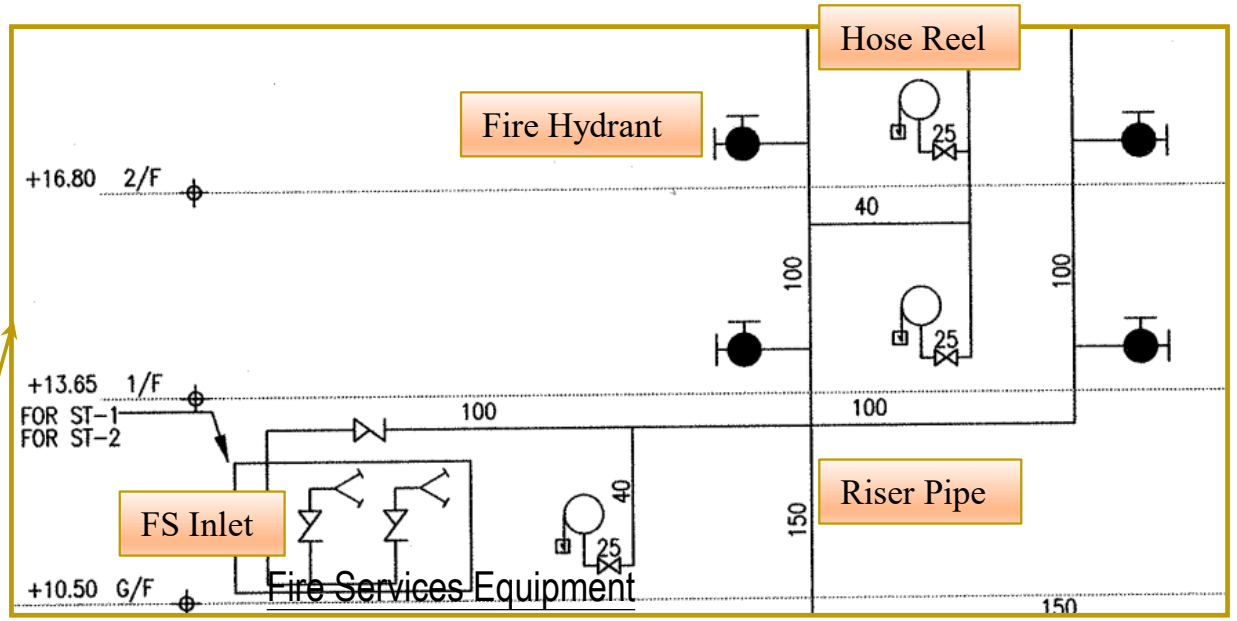
Legends/symbol used in fire services systems

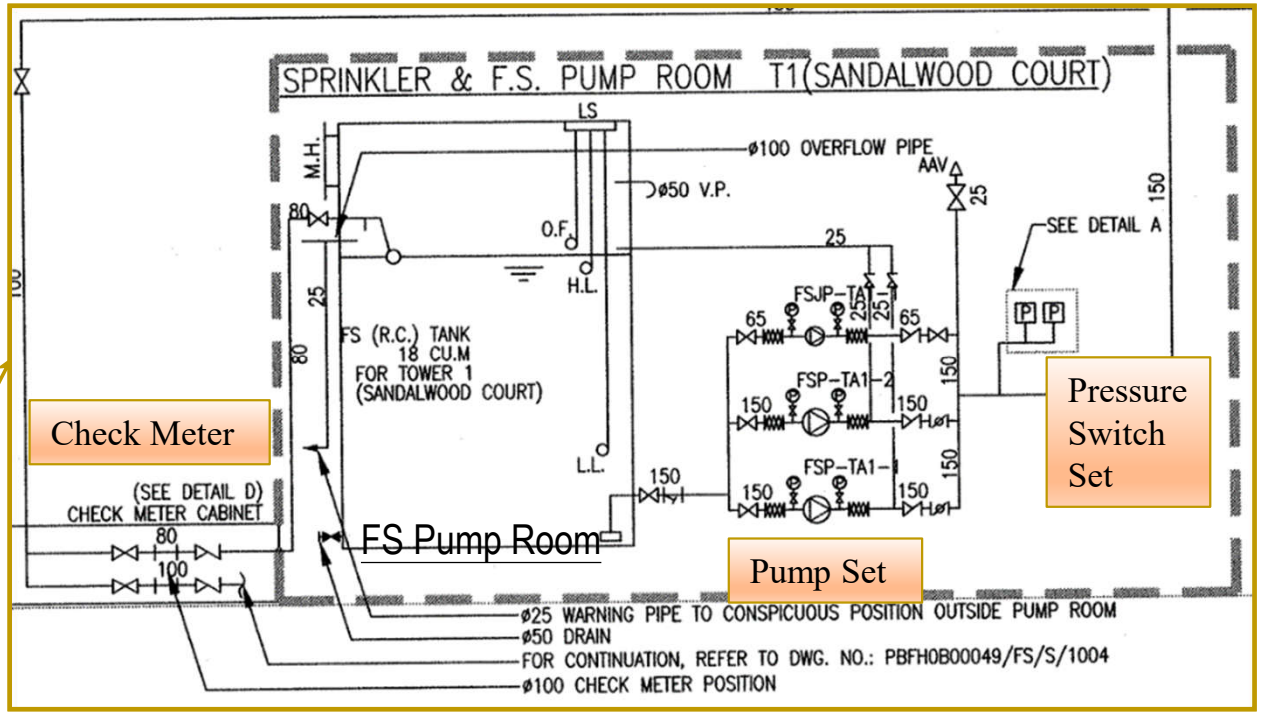
LEGENDS

- GATE VALVE
- CHECK VALVE
- Y–TYPE STRAINER
- DRAIN VALVE C/W PLUG
- PRESSURE RELIEF VALVE
- BALL FLOAT VALVE
- FLEXIBLE PIPE CONNECTOR
- VORTEX INHIBITOR
- PRESSURE SWITCH ASSEMBLY
- PRESSURE GAUGE C/W COCK
- ORIFICE PLATE
- FLOAT SWITCH
- PUMP SET C/W ELECTRIC MOTOR
- PUDDLE FLANGE
- AUTOMATIC AIR VENT
- HOSE REEL C/W 30M RUBBER HOSE (OUTLET TO BE HOUSED UNDER GLASS FRONT CABINET UNDER LOCKED)
- CHECK METER POSITION
- FIRE SERVICES INLET C/W DRAIN VALVES & PLUGS
- FIRE HYDRANT OUTLET (SINGLE OUTLET TYPE)
- FIRE HYDRANT OUTLET (PRV TYPE)
- DIRECT READING METER
- FLOW SWITCH
- PRESSURE RELIEF VALVE
- FLEXIBLE CONNECTOR
- BYPASS VALVE PIT KEPT CLOSE (WITH LOCKABLE DEVICE)
- LOCAL FIRE PUMP CONTROL PANEL
- SPRINKLER HEAD, SINGLE LAYER UNDER CEILING SLAB
- SPRINKLER HEAD, SINGLE LAYER UNDER FALSE CEILING
- SPRINKLER HEAD, DOUBLE LAYER LOWER LAYER WITH CONCEALED PLATE
- SPRINKLER SYSTEM ALARM VAVLE SET
- SPRINKLER SYSTEM ALARM VAVLE SET (SCHEMATIC)
- SPRINKLER INET C/W DRAIN VALVES & PLUGS
- SUBSIDIARY STOP VALVE W/ ELECTRIC MONITORING
- SPRINKLER PIPE
- SFH PIPE
- FS PIPE

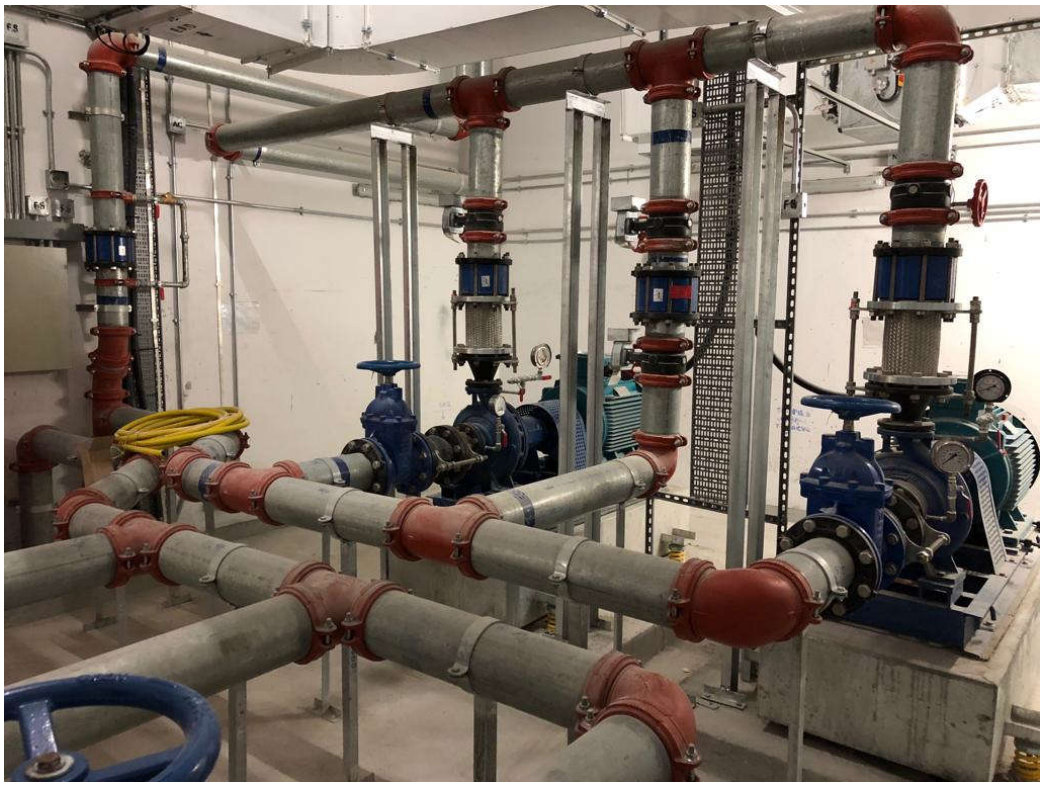
Typical arrangement of fire hydrant/hose reel system







Example of a pump room for FH/HR system



Fire Services Pump

Fire Services Pump Control Panel

- 2 nos. fire services main pumps (duty & standby) with jockey pump
- One set of fire services pump control panel
- Water tank (reinforced concrete or fibreglass)

Fire hydrant/hose reel system

- Type of fire hydrants (消防栓):
  - 1. Street fire hydrant system
    - Use as a water well to supply water for fire brigade
  - 2. External fire hydrant system
    - For fireman to extinguish the fire in open area e.g. railway station, building development where fire brigade cannot arrive
  - 3. Internal fire hydrant system
    - For fireman to extinguish the fire inside building

Installation of street fire hydrant

SECTION A – A

NOTES :

1. THE CAP OF THE CONTROL VALVE SPINDLE SHOULD BE AT 250mm APPROX. BELOW THE VALVE COVER AND IN NO CASE SHOULD THE DISTANCE BE MORE THAN 500mm.

[Source: HKFSD]

Fire hydrant/hose reel system

- Fire hydrants (internal)
  - Designed for firemen's use without having to connect the water hose from ground level during fire fighting
  - Fire hydrants are installed inside every protective staircases so that firemen can plug in their 65mm fire hose to obtain water
  - Fire hydrants are sited in the approach lobby to staircase or in the staircase enclosure
  - Either wet or dry riser can be used

Types of fire hydrant (1)

	Male Round Thread	Female Instantaneous
Single Outlet		
Single Outlet with Parity Valve		

Types of fire hydrant (2)

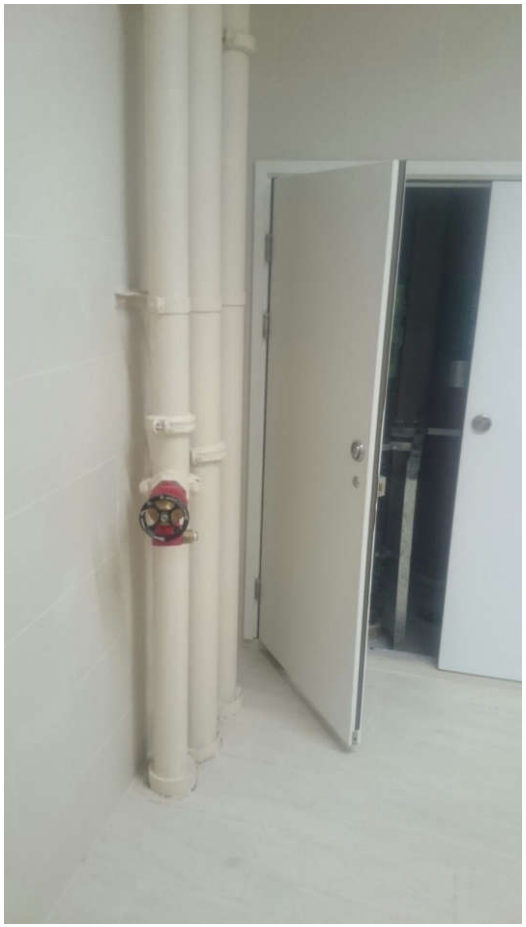
	Male Round Thread	Female Instantaneous
Single Outlet (Pressure Release - Ratio Type)		
Single Outlet (Pressure Regulating Type)		

Types of fire hydrant (3)

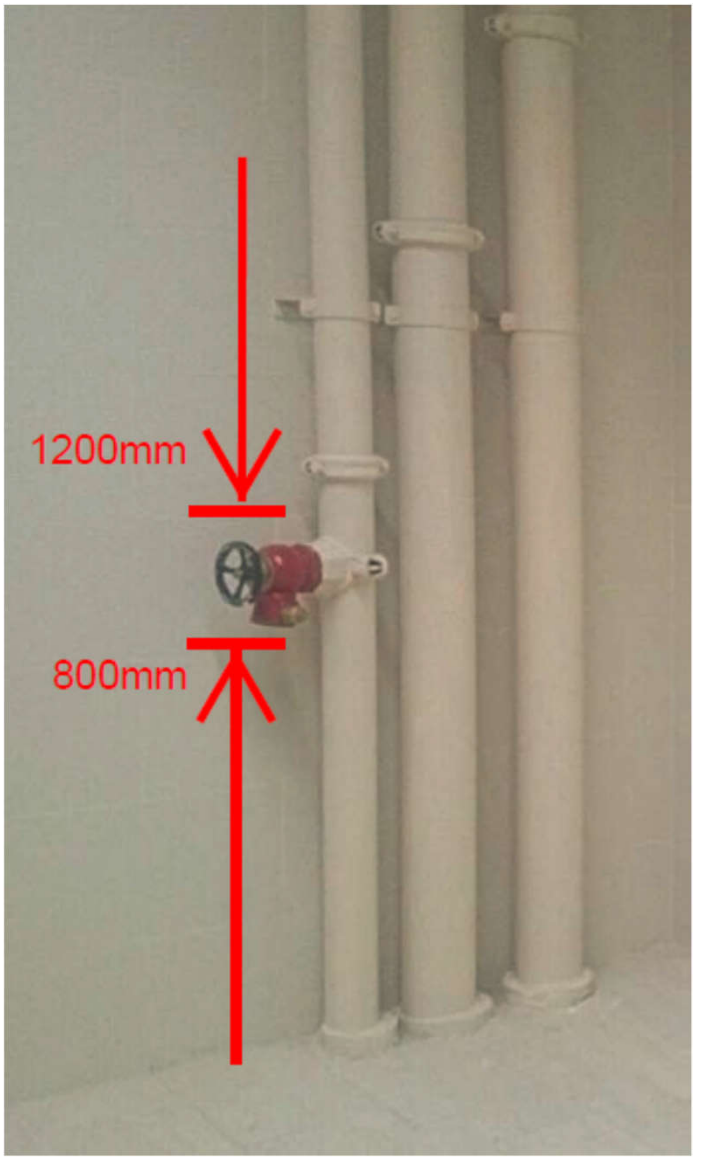
	Male Round Thread	Female Instantaneous
Twin Outlets with individual control		
Twin Outlets with individual control with Parity Valve		

General fire hydrant positioning in buildings

Fire Hydrant in Staircase



Fire Hydrant in
Protected Corridor



Fire Hydrant -
Single Outlet

Fire Hydrant –
Single Outlet with Parity Valve

Types of fire services inlet and its positioning in buildings

	Typical Type of Fire Services Inlet used in HK
Twin Inlet (Male-instantaneous type)	  

FS Inlets sited at a prominent position on the exterior of building

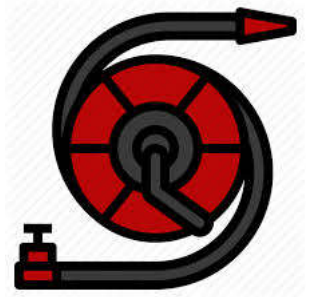
FS Inlets in cabinet

Design requirements of fire hydrant system

Building Type	System	Fixed Fire Pump		Intermediate Booster Pump	
		Flow	Running Pressure	Flow	Running Pressure
Industrial / Godwin Buildings	1 Rising Main	450 l/min. x 3 Outlet 1350 l/min x 1 Outlet	350kPa – 850kPa	1350l/min. x 1 Outlet 450l/min. x 3 Outlet	350kPa – 850kPa
	2 Or More Rising Mains			2700l/min. x 1 Outlet 450 l/min. x 6 Outlet	
Domestic Buildings	NA	450 l/min. x 2 Outlet 900 l/min. x1 Outlet		900l/min. x 1 Outlet 450l/min. x 2 Outlet	
Other Buildings	1 Rising Main			900l/min. x 1 Outlet 450l/min. x 2 Outlet	
	2 Or More Rising Mains			1800l/min. x 1 Outlet 450l/min. x 4 Outlet	

[Source: HKFSD]

Fire hydrant/hose reel system



- Hose reels (消防喉轆)
  - Enable first hand fire fighting by occupants
  - Hose reels are provided to ensure that every location in a floor is within the reach of the hose
  - Each hose reel has a 30 m long tube
  - A minimum of 6 m length water jet from the hose reel nozzle has to be provided

Types of hose reel

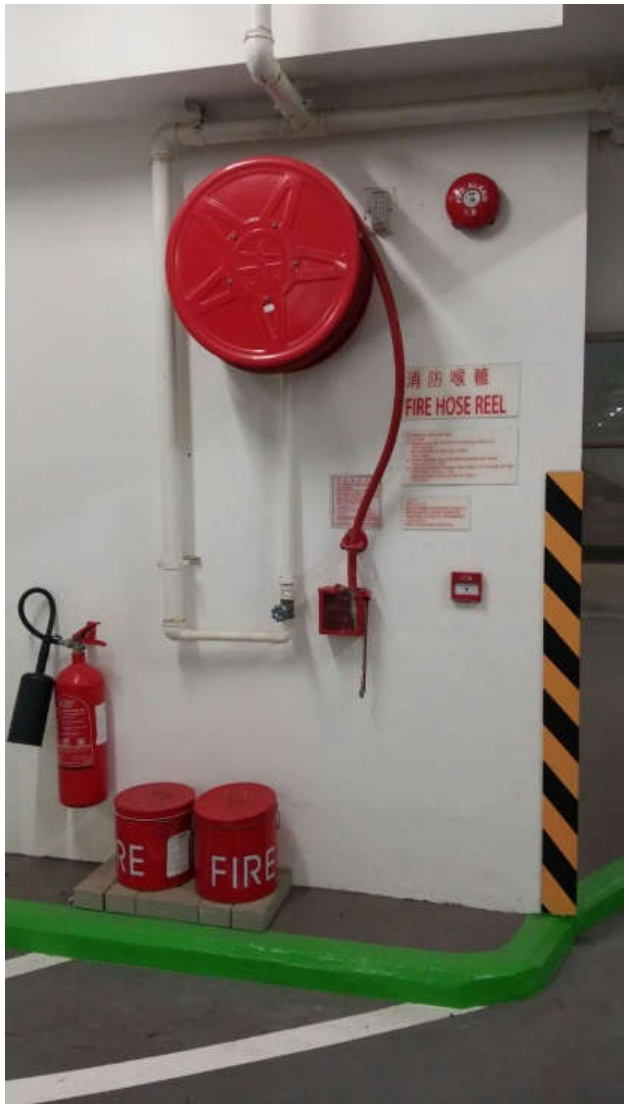
Fixed Type Fire Hose Reel	Recess Swing Type (90º) Fire Hose Reel	Swing Type (180º) Fire Hose Reel
		

General hose reel positioning in buildings

Recessed Type (90° Swing Type HR in cabinet)

Recessed Type (180° Swing Type HR in cabinet)

Cabinet for Hose Reel



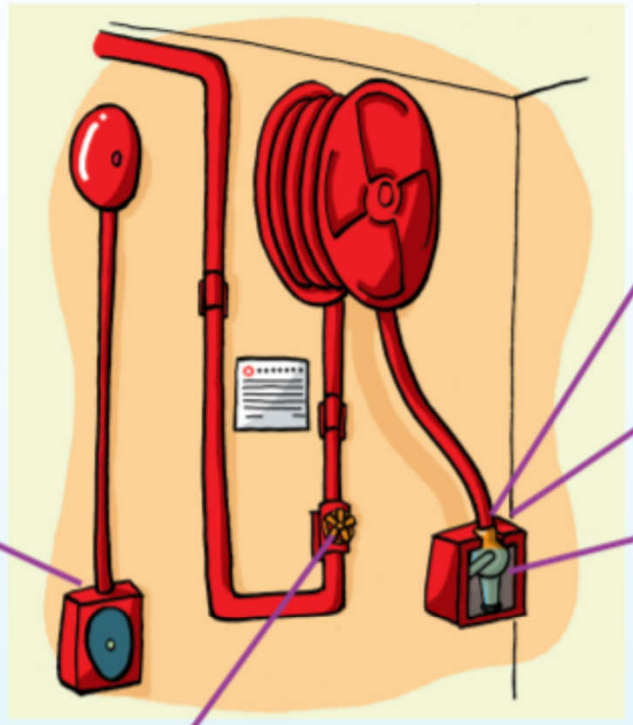
Exposed Type (Surface mount)

正確使用消防喉轆
The Correct Way To Operate Fire Hose Reels

一旦發生火警，在安全情況下，可使用消防喉轆防止火勢蔓延。但不要因為使用消防裝備而延誤逃生。

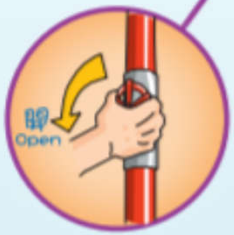
In case of fire and if conditions are safe, use a fire hose reel to stop the fire from spreading. Using fire service installations should not delay your escape.

消防喉轆的正確使用方法：
The correct way to operate a fire hose reel:



1 打爛玻璃，以啟動警鐘及消防泵
Break glass to sound the fire alarm and start fire pump

2 開啟來水掣
Open control valve



5 開啟射嘴掣，射向火源底部（不適用於電火）
Turn on water and direct jet at base of fire (not suitable for electrical fires)

4 拉出消防喉
Pull out the hose

3 擊碎射嘴玻璃盒
Break glass of the nozzle enclosure

使用消防喉轆時，應注意：
When using the fire hose reel, ensure that:

- 須先確定有安全的撤退路徑。
  There is a safe escape route.
- 若火勢失去控制，應立即逃生。
  Leave immediately if the fire gets out of control.

Smoke management & control

- Smoke control system
  - An engineered electro-mechanical system that uses mechanical fans & dampers in cooperation with electronic monitoring & controls to produce pressure differences across smoke barriers which inhibit or facilitate smoke movement
- Smoke management system
  - An engineered mechanical system that, based on its intended purpose, uses mechanical fans, dampers and other methods to remove smoke from a facility under post fire condition

[Source: https://blog.1sae.com/2014/11/10/smoke-control-vs-smoke-management-an-overview/]

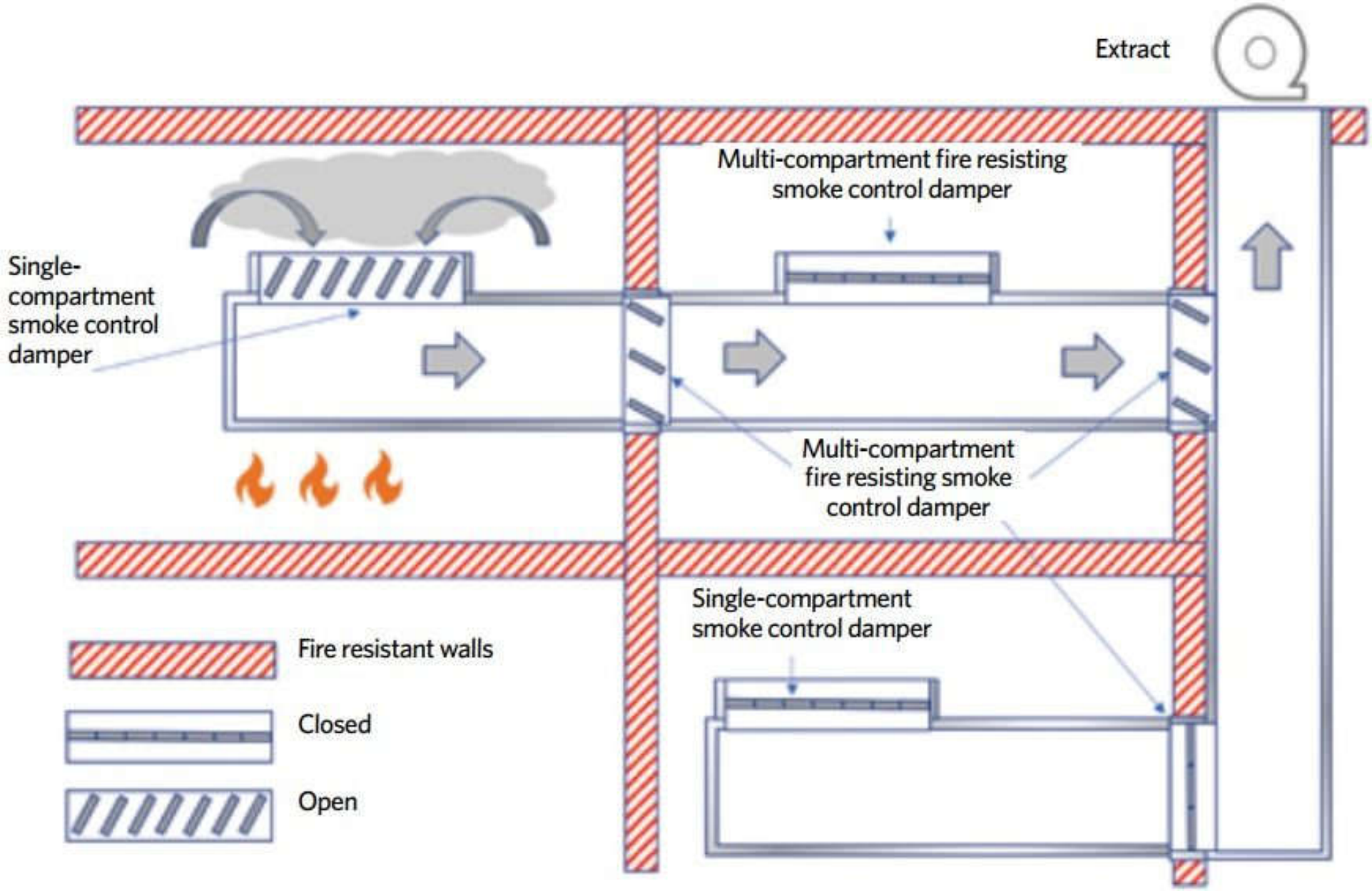
Smoke management & control

- Fire & smoke dampers for ventilation systems
  - Compartmentation & smoke control
  - Control of smoke and containment of fire in the ventilation ductwork
  - Fire damper: maintain compartmentation and prevent, or impede, the spread of fire through the ventilation ductwork
  - Smoke damper: control the flow of smoke and hot gases into, from or within a duct

Examples of a fire damper (right) and a smoke damper (left)

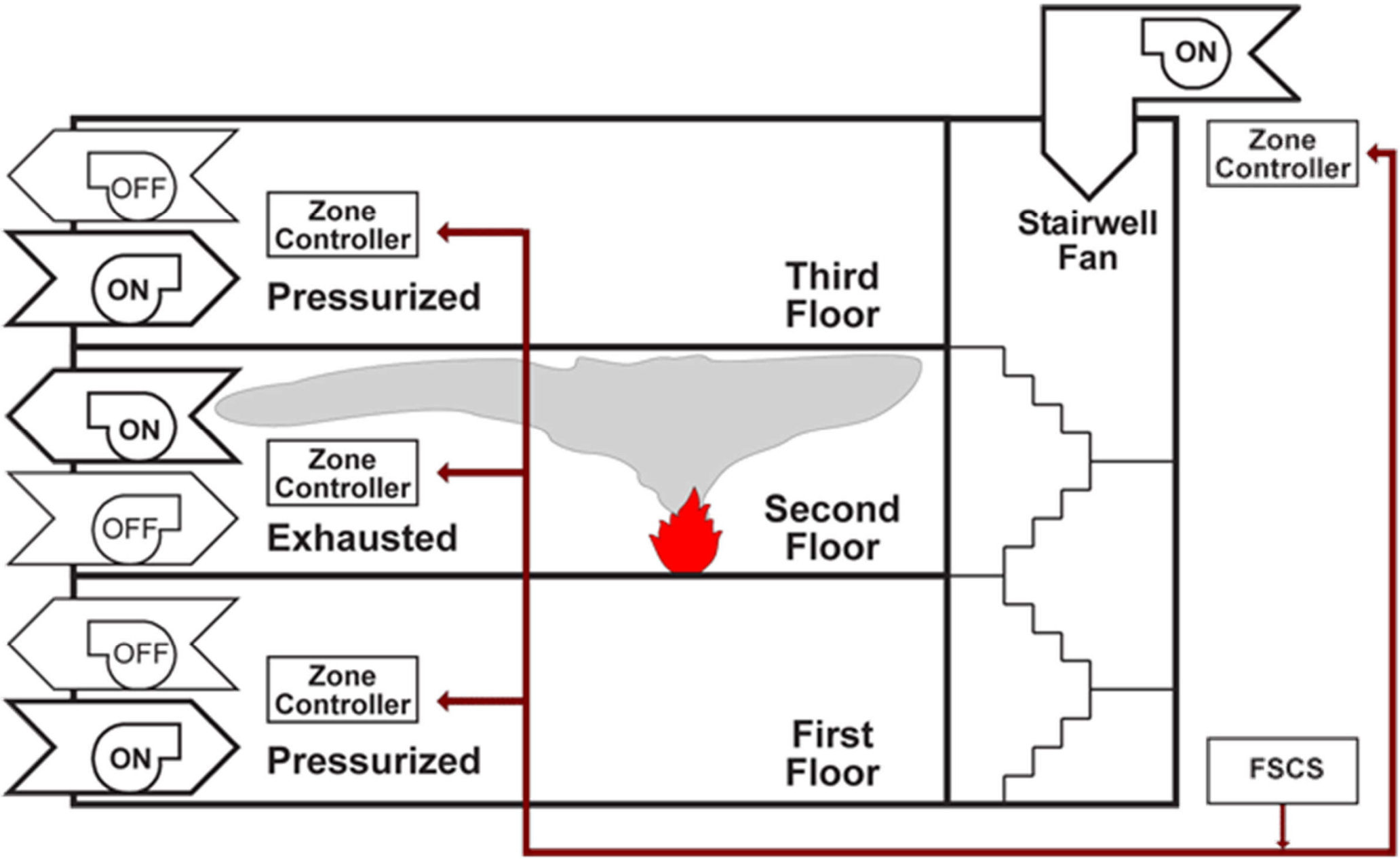
[Source: https://www.cibsejournal.com/cpd/modules/2019-12-dam/]

Location of dampers for fire & smoke control for a basement application, with dampers set as if smoke is detected in the top left compartment

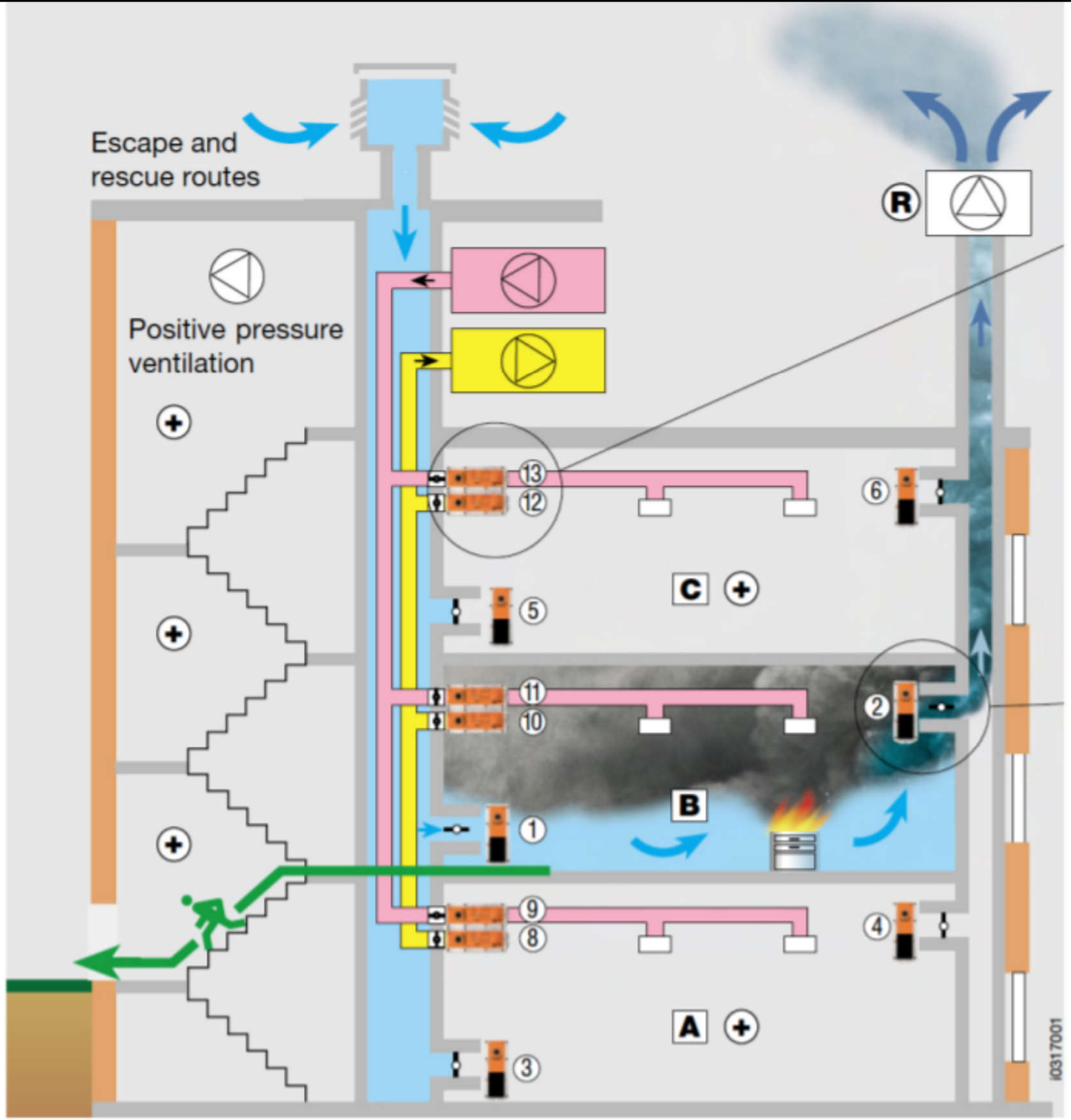


[Source: https://www.cibsejournal.com/cpd/modules/2019-12-dam/]

An example of smoke control system in buildings



[Source: http://www.kmccontrols.com.hk/products/smoke_control.html]



Operation of ventilation and smoke extraction systems during fire situation

[Source: http://dipecholac.net/docs/files/224-hospitals-dont-burn-hospital-fire-prevention-and-evacuation-guide.pdf]