# CENTRAL POLYTECHNIC COLLEGE

## THARAMANI, CHENNAI

## Regulation 2023

## 1122 Diploma in Fire Technology and Safety

| | | | | | |
|---|---|---|---|---|---|
| 1122233110 | Fire Engineering | L | T | P | C |
| Theory | | 3 | 0 | 0 | 3 |

**Prepared by**

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| UNIT 4 | INDUSTRIAL FIRE PROTECTION SYSTEMS |
|---|---|

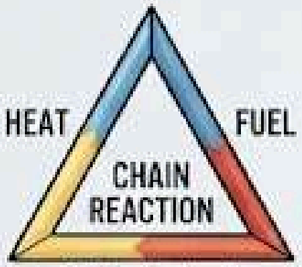
**Protection systems :** Sprinkler-hydrants-stand pipes – special fire suppression systems like deluge and emulsifier, selection criteria of the above installations, reliability, maintenance, evaluation and standards - alarm and detection systems. Other suppression systems – $CO_2$ system, foam system, dry chemical powder (DCP) system, halon system – need for halon replacement – smoke venting. Portable extinguishers – flammable liquids – tank farms – indices of inflammability - fire fighting systems.

**Building fire safety :** Objectives of fire safe building design, Fire load, fire resistant material and fire testing – structural fire protection – structural integrity – concept of egress design - exist – width calculations – fire Certificates – fire safety requirements for high rise buildings –snookers.

# INTRODUCTION TO INDUSTRIAL FIRE PROTECTION SYSTEMS

## I. FIRE BASICS & CLASSES

### A. FIRE TRIANGLE




(Tetrahedron)

- REMOVE ONE TO EXTINGUISH FIRE.

### B. FIRE CLASSES

CLASS A
(Solid Combustibles: Wood, Paper)

CLASS B
(Flammable Liquids: Oil, Gas)

CLASS C
(Electrical Equipment)

CLASS D
(Combustible Metals)

- KEY FOR SELECTING SYSTEM TYPE.

## II. DETECTION SYSTEMS

### A. SMOKE DETECTORS


- OPTICAL/IONIZATION TYPES.
- SENSE VISIBLE/INVISIBLE PARTICLES.
- ACTIVATES ALARM.

### B. HEAT DETECTORS


- RATE-OF-RISE OR FIXED TEMP.
- TRIGGERED BY ABNORMAL HEAT.

### C. FLAME DETECTORS


- SENSES RADIATION FROM FLAMES.
- USED IN HIGH-RISK ZONES (e.g., OIL RIGS).

## III. SUPPRESSION SYSTEMS

### A. AUTOMATIC SPRINKLER SYSTEM


- WET/DRY PIPE SYSTEMS.
- HEAT BREAKS BULB, RELEASES WATER.
- MOST COMMON ACTIVE SUPPRESSION.

### B. GASEOUS SYSTEMS

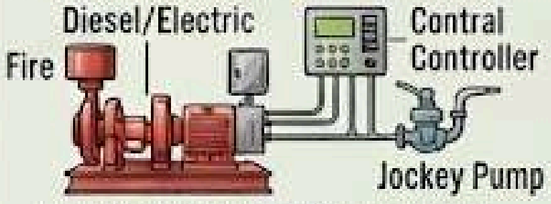

- FLOODS ROOM, REDUCES OXYGEN/INTERRUPTS CHAIN REACTION.
- NO RESIDUE.
- FOR ELECTRICAL/SERVER ROOMS.

### C. FOAM SYSTEMS


- BLANKETS FLAMMABLE LIQUID FIRES.
- SUITABLE FOR FUEL STORAGE.

## IV. KEY COMPONENTS & STRATEGY

### A. FIRE PUMP SYSTEM




- MAINS WATER PRESSURE BOOST.
- ENSURES ADEQUATE FLOW & PRESSURE.

### B. FIRE ALARM CONTROL PANEL (FACP)


- BRAIN OF THE SYSTEM.
- MONITORS DEVICES, SOUNDS ALARMS, INTERFACES WITH OTHER SYSTEMS.

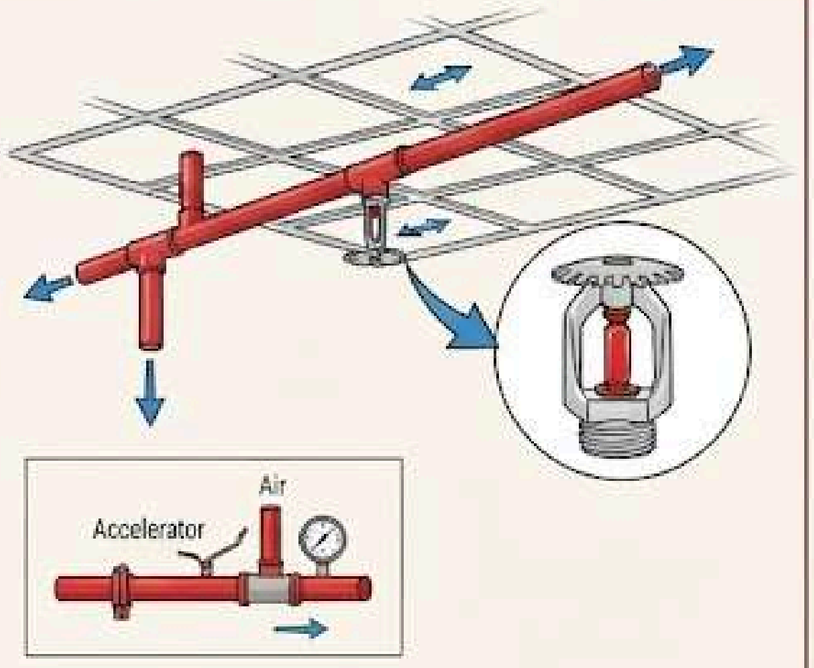
### C. EMERGENCY COMMUNICATION


- MANUAL PULL STATIONS, HORN/STROBES.
- ESSENTIAL FOR PERSONNEL EVACUATION.

EDUCATIONAL MATERIAL FOR DIPLOMA STUDENTS. SOURCE: NFPA STANDARDS (INDICATIVE).

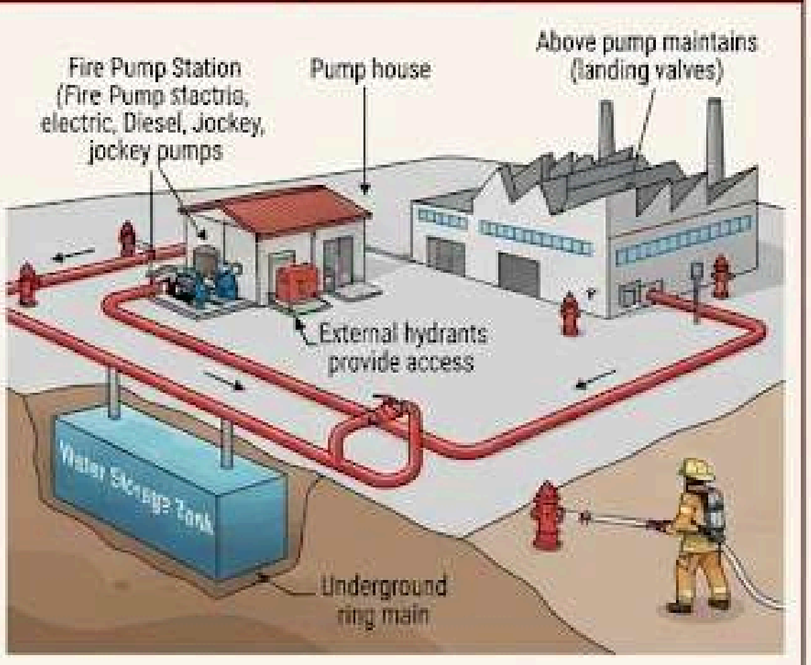
# INDUSTRIAL FIRE PROTECTION SYSTEMS: KEY COMPONENTS FOR DIPLOMA STUDENTS

## AUTOMATIC SPRINKLER SYSTEM



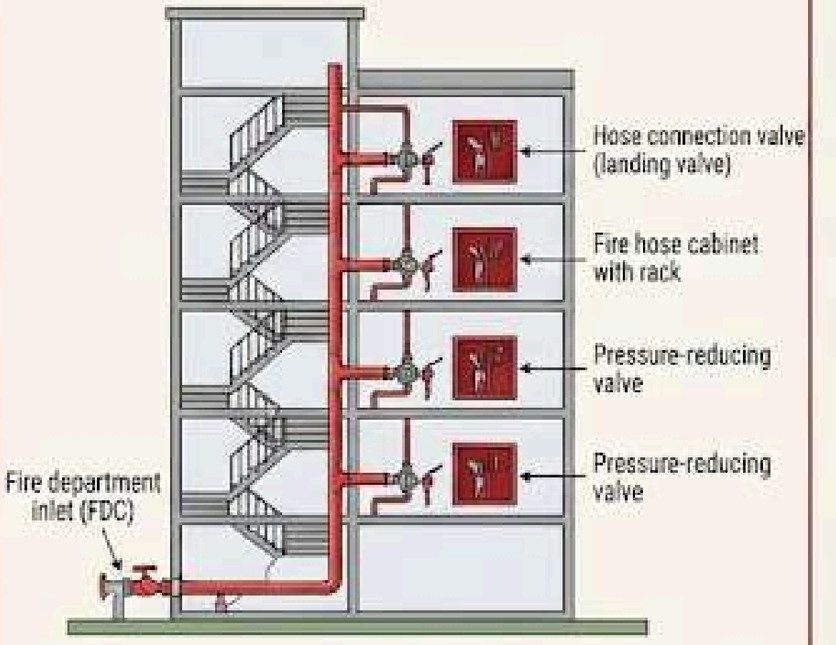

- Heat from fire breaks glass bulb/fusible link.
- Water discharges immediately over the fire zone.
- Wet Pipe: Pipes filled with pressurized water (most common).
- Dry Pipe: Pipes filled with air/nitrogen, used in cold areas.
- Automatic activation, localized suppression.

## FIRE HYDRANT SYSTEM (YARD MAIN)




- High-pressure network for large-scale firefighting.
- Water supplied by storage tank and fire pumps.
- Jockey pump maintains system pressure.
- External hydrants provide access for fire brigades.
- Supports multiple hoses for high-volume water application.

## STANDPIPE SYSTEM (INTERNAL RISER)




- Fixed piping network installed vertically within buildings.
- Provides readily available water connections on each floor.
- Class I: For fire service use (2.5" connection).
- Class II: For trained occupant use (1.5" hose station).
- Eliminates need to lay long hoses up stairwells.
- Essential for high-rise/large facility firefighting.

## 1. Automatic Sprinkler Systems

Sprinklers are active fire suppression systems designed to detect heat from a fire at an early stage and discharge water automatically.

- **Working Principle:** Each sprinkler head contains a heat-sensitive glass bulb (filled with a liquid) or a fusible link. When the ambient temperature reaches a specific rating, the bulb breaks, opening the valve to release water directly over the fire zone.
- **Types:**
  - **Wet Pipe Systems:** Pipes are constantly filled with pressurized water for immediate discharge (most common).
  - **Dry Pipe Systems:** Pipes contain compressed air; water enters only when a fire opens the valve, preventing freezing in cold environments.
- **Key Benefit:** Confines or extinguishes the fire automatically before it spreads, minimizing structural and property damage.

## 2. Fire Hydrant Systems

Hydrant systems are external or internal high-pressure water networks designed to supply a large volume of water for firefighters to combat major industrial blazes.

- **Components:** Comprises an underground water storage tank, fire pumps (main diesel/electric pump and a jockey pump to maintain line pressure), a network of steel ring mains, and external yard hydrants/landing valves.
- **Working Principle:** Firefighters connect heavy-duty hoses and branch pipes to the hydrant outlet (landing valve), open the valve, and use pressurized water streams to suppress large-scale fires.
- **Key Benefit:** Provides a continuous, heavy-duty water supply when portable fire extinguishers are insufficient.

## 3. Standpipe Systems

A standpipe system is a fixed network of piping installed inside multi-story buildings or large industrial plants to transport water vertically to various floors or zones.

- **Components:** Water supply connection (from a fire pump or fire brigade inlet), vertical riser pipes, hose connections/landings on each floor, and pressure-regulating devices.
- **Types:**
  - **Class I:** Designed for trained fire personnel/brigades (uses 2.5-inch connections).
  - **Class II:** Designed for building occupants for initial use (uses 1.5-inch hoses).
  - **Class III:** Combines both capabilities.
- **Key Benefit:** Eliminates the need for firefighters to drag long, heavy hoses up multiple stairwells, ensuring rapid response in high-rise structures.

# INDUSTRIAL FIRE PROTECTION SYSTEMS: SPRINKLERS, HYDRANTS & STANDPIPES

## 1. AUTOMATIC SPRINKLER SYSTEM

- Active suppression system triggered by heat.
- Glass bulb breaks at specific temperature threshold.
- Wet Pipe (water filled) & Dry Pipe (air filled) types.
- Automatically discharges water directly over fire zone.

## 2. FIRE HYDRANT SYSTEM

- High-pressure water network for major industrial fires.
- Comprises storage tank, ring mains & fire pumps.
- Main Electric, Diesel & Jockey pumps maintain flow.
- Firefighters hook hoses up to external landing valves.

## 3. STANDPIPE SYSTEM

- Fixed vertical piping network inside multi-story plants.
- Transports water efficiently to elevated building levels.
- Class I, II, and III types based on user capability.
- Eliminates dragging heavy hoses up stairwells.

| Feature | Automatic Sprinklers | Fire Hydrant System | Standpipe System |
|---|---|---|---|
| **Primary Use** | Early detection & automatic suppression | Supplying high-volume water for major fires | Vertical water transport in multi-story plants |
| **Trigger Mechanism** | Heat-sensitive glass bulb breaking | Manual opening of landing valves/hoses | Manual connection via fire brigade inlet or risers |
| **Main Components** | Piping network, glass bulb heads, water supply | Underground tank, ring mains, jockey/diesel pumps | Vertical risers, floor hose connections, pressure valves |

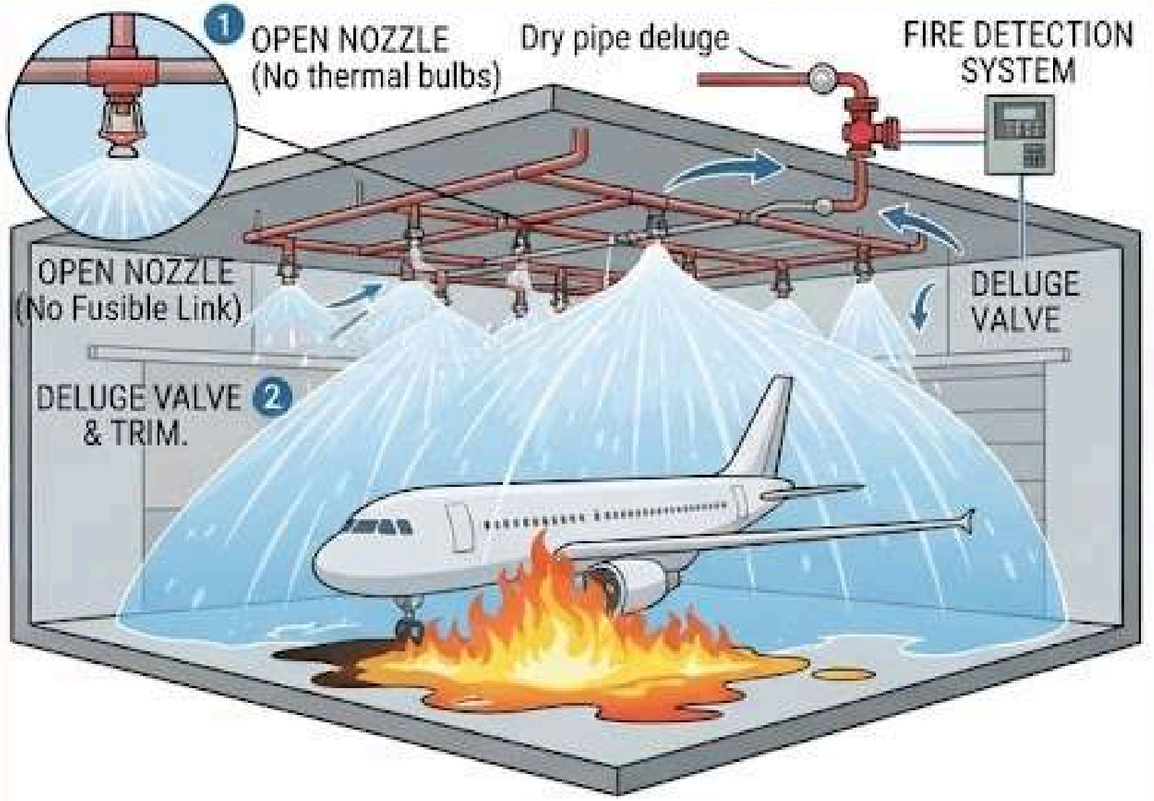
## 1. Deluge Fire Suppression System

A deluge system is a specialized fixed-pipe active suppression system designed for high-hazard, fast-spreading fire risks.

- **Working Principle:** Unlike standard sprinklers, all sprinkler heads in a deluge system remain **open** at all times (they do not have individual thermal bulbs or links). The piping is dry until a separate fire detection system (smoke or heat detectors) triggers a central **deluge valve**.
- **Simultaneous Discharge:** When triggered, the valve opens, allowing water to flow into the piping network and discharge out of *all* open nozzles simultaneously, flooding the protected zone.
- **Key Applications:** Aircraft hangars, chemical processing plants, explosives storage, and power transformer yards where fires can spread instantly.

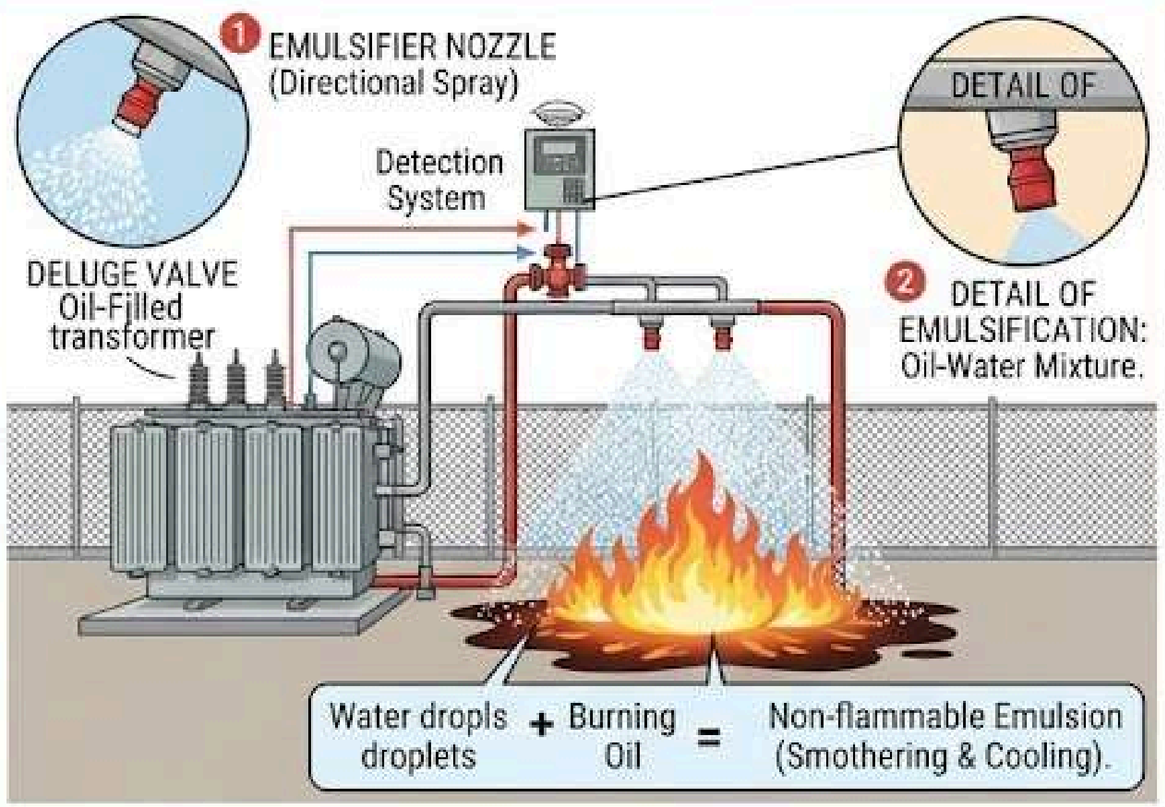
# SPECIAL FIRE SUPPRESSION SYSTEMS: DELUGE & EMULSIFIER

## DELUGE SYSTEM (HIGH HAZARD)




1. All nozzles remain open.
2. Activated by separate detection system.
3. Deluges entire area simultaneously.
4. For high-hazard, fast-spreading fires (e.g., hangars).

## WATER SPRAY (EMULSIFIER) SYSTEM (FLAMMABLE LIQUID)




1. Uses directional high-velocity spray.
2. Creates an oil-in-water emulsion.
3. Cools and smothers simultaneously.
4. Specific for flammable liquid fires (e.g., transformers, turbines).

EDUCATIONAL REFERENCE DIAGRAM FOR DIPLOMA IN FIRE & SAFETY ENGINEERING.

## 2. Water Spray (Emulsifier) System

An emulsifier system is engineered specifically to handle Class B fires involving flammable and combustible liquids (such as heavy oils, transformer oils, and diesel).

- **Working Principle:** It utilizes specialized directional **emulsifier nozzles** (discharge nozzles) that break water streams into a fine, high-velocity water mist.
- **Emulsification Process:** When the water spray hits the burning oil surface, it creates a non-flammable "oil-in-water" or "water-in-oil" **emulsion**. This prevents the release of flammable vapors, rapidly cools the liquid below its flash point, and extinguishes the fire through surface cooling and smothering.
- **Key Applications:** Oil-filled electrical transformers, turbine lube oil systems, pump houses, and petrochemical storage facilities.

| Feature | Deluge System | Water Spray (Emulsifier) System |
| --- | --- | --- |
| **Nozzle Status** | Open nozzles (no thermal bulbs) | Emulsifier/directional spray nozzles |
| **Activation** | Electronic detection loop opening a central deluge valve | Automatic detection or manual actuation linked to a deluge valve |
| **Primary Target** | High-hazard areas requiring massive blanket coverage | Flammable liquid fires (transformers, oil tanks) |
| **Extinguishing Action** | Massive simultaneous water deluge | Surface cooling and creating a chemical-physical emulsion layer |

# selection criteria of the  Deluge Systems and Water Spray (Emulsifier) Systems

- **Nature and Class of Fire Hazard:**
  - Deluge systems are chosen for extra-hazard areas where fires spread rapidly across large surfaces (such as aircraft hangars).
  - Water spray (emulsifier) systems are specific for flammable liquid fires (such as transformers and turbines).
- **Discharge Mechanism:**
  - Deluge systems utilize open nozzles without thermal elements or fusible links, allowing all nozzles to remain open and discharge simultaneously.
  - Emulsifier systems utilize directional high-velocity spray nozzles to create an oil-water emulsion that cools and smothers the fire simultaneously.
- **Activation Method**: Both systems are activated by separate external fire detection systems that trigger a central deluge valve.

# Reliability, Maintenance, Evaluation and Standards of installations

- **System Reliability:**
  - High dependability due to the use of a central deluge valve and independent fire detection loops.
  - Open nozzles eliminate the risk of stuck thermal bulbs or closed valves during emergencies.
- **Maintenance Requirements:**
  - Regular functional testing of the central deluge valve and electronic detection/alarm panels.
  - Periodic flushing of piping networks and inspection of open/emulsifier nozzles to prevent clogging from debris, corrosion, or scale.
  - Routine testing of fire pumps (diesel, electric, and jockey pumps) and water storage tank levels.

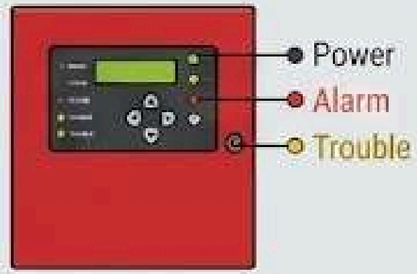
# Reliability, Maintenance, Evaluation and Standards of installations

- **Evaluation & Testing:**
  - Periodic trip tests of the deluge valve to verify quick response times and proper water delivery across the system.
  - Hydraulic performance checks to ensure adequate flow rate, pressure, and spray coverage at the farthest hazard points.
- **Applicable Standards:**
  - Design, installation, and maintenance governed strictly by international and national standards such as **NFPA 15** (Standard for Water Spray Fixed Systems for Fire Protection) and local fire safety codes.

# Alarm and Detection Systems

## INDUSTRIAL FIRE ALARM & DETECTION SYSTEMS

### A. FIRE ALARM CONTROL PANEL (FACP)




CENTRAL "BRAIN" OF THE SYSTEM.
MONITORS INPUTS, ACTIVATES OUTPUTS,
INTERFACES WITH SUPPRESSION.

### B. INITIATING DEVICES (DETECTORS)

1. SMOKE DETECTOR
(Optical/Ionization)

2. HEAT DETECTOR
(Fixed Temperature/Rate-of-Rise)

3. FLAME DETECTOR
(IR/UV)

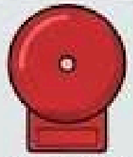
DETECTS FIRE PHENOMENA (SMOKE, HEAT, RADIATION) AND SENDS SIGNAL TO FACP.

### C. MANUAL & AUDIBLE/VISUAL DEVICES

1. MANUAL


2. HORN/STROBE

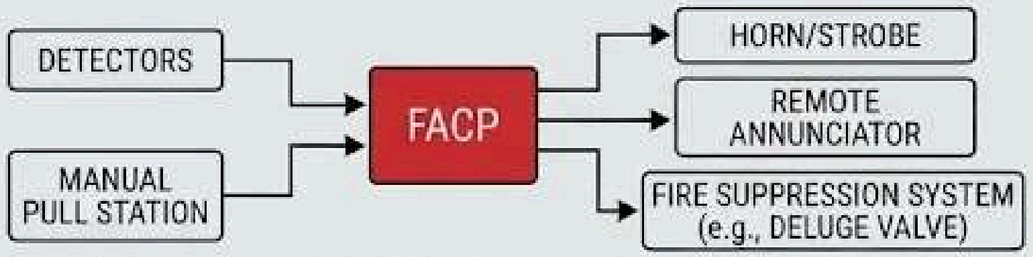
3. ALARM BELL



1. MANUAL PULL STATION
2. HORN/STROBE
3. ALARM BELL

MANUALLY ACTIVATES ALARM; NOTIFIES OCCUPANTS (SOUND/LIGHT) FOR EVACUATION

### D. SYSTEM INTEGRATION SCHEMATIC




SHOWS INTERCONNECTION OF COMPONENTS & INTERFACE WITH OTHER SYSTEMS

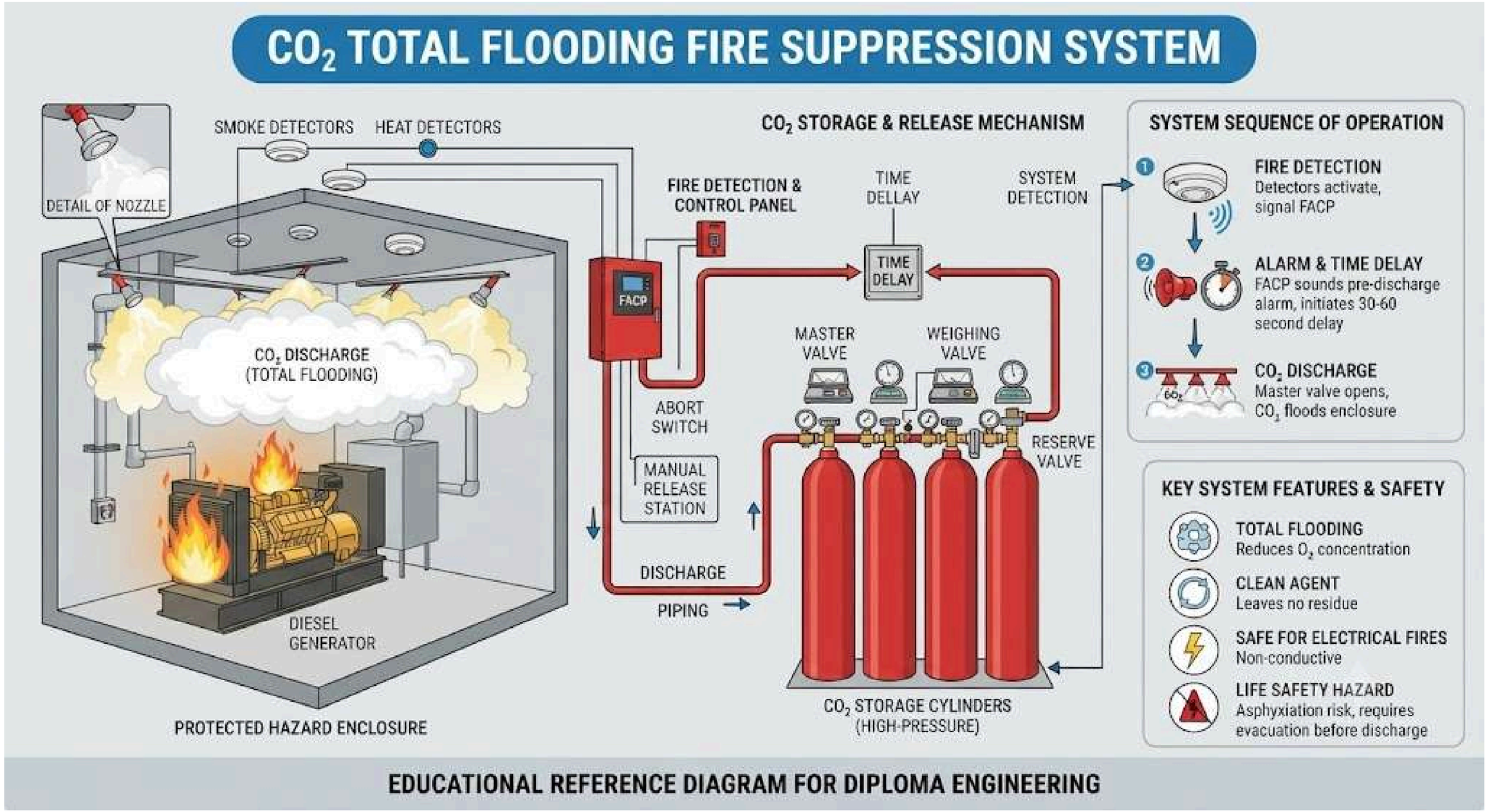
### E. TYPICAL INSTALLATION LAYOUT


ILLUSTRATES DEVICE PLACEMENT
WITHIN A BUILDING STRUCTURE

# Alarm and Detection Systems

- **Fire Alarm Control Panel (FACP):** Serves as the central "brain" of the system, continuously monitoring detection inputs, triggering alarms, and interfacing with suppression systems.
- **Smoke Detectors:** Optical or ionization-based sensors that detect visible or invisible combustion particles to provide early fire warnings.
- **Heat Detectors:** Fixed-temperature or rate-of-rise devices that activate when abnormal thermal increases are detected.
- **Flame Detectors:** Sensors that detect infrared (IR) or ultraviolet (UV) radiation emitted by flames, commonly deployed in high-risk zones.
- **Manual & Notification Devices:** Manual pull stations, horns, and strobes used to alert building occupants and facilitate safe evacuation.

# CO2 suppression systems



# CO2 suppression systems

- **Extinguishing Mechanism:** Floods the enclosed room or hazard space, rapidly reducing oxygen concentration and interrupting the fire's chemical chain reaction.
- **Residue-Free Agent:** Utilizes carbon dioxide, which is a clean agent that leaves zero residue, preventing water or chemical damage to protected assets.
- **Primary Applications:** Highly suitable for enclosed electrical rooms, server/data centers, generator rooms, and machinery spaces.
- **Life Safety Hazard:** Poses a severe suffocation (asphyxiation) hazard to humans; requires mandatory pre-discharge alarms, time delays, and safe evacuation before release.

# foam suppression system

# foam suppression system

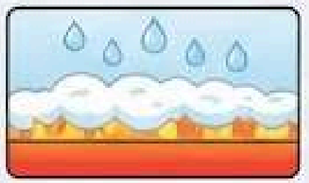
## FOAM-WATER FIRE SUPPRESSION SYSTEM: PRINCIPLES & COMPONENTS

### 1. FOAM SUPPRESSION MECHANISMS

#### A. SMOTHERING (OXYGEN DEPLETION)

Forms a stable blanket over fuel surface, cutting off oxygen supply.

#### B. COOLING (HEAT REDUCTION)

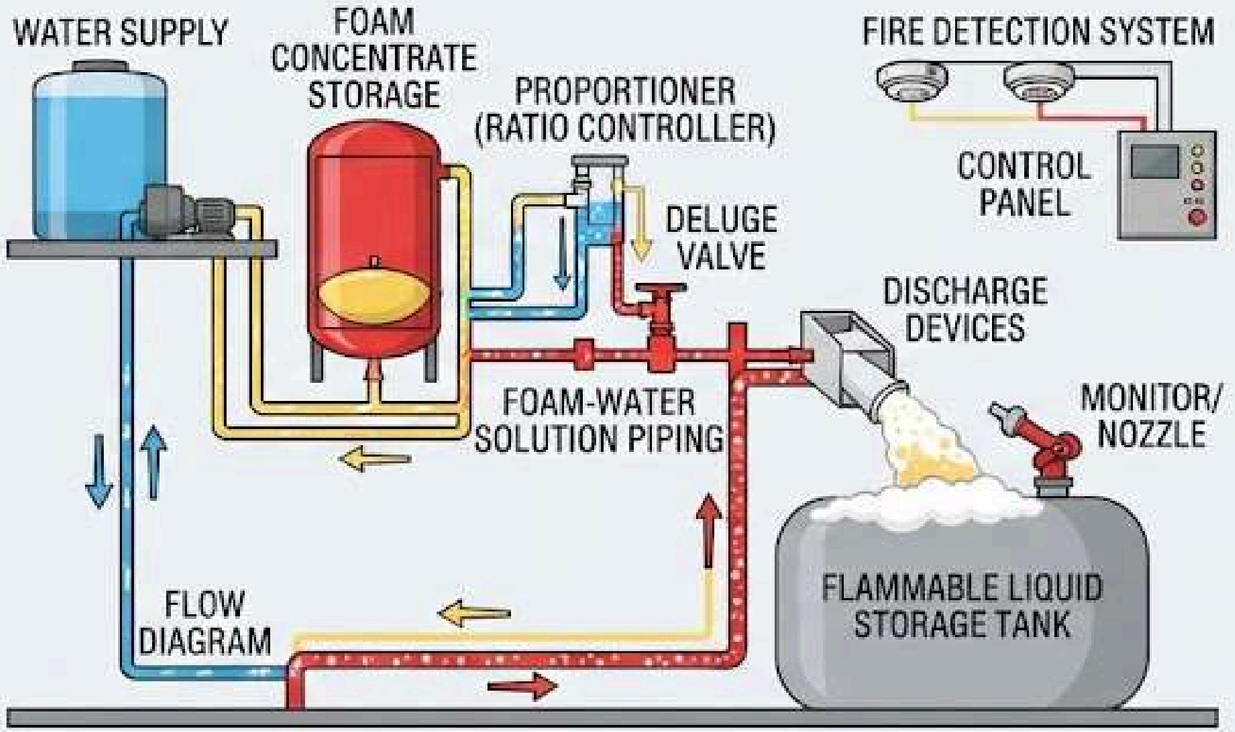


Water in foam absorbs heat, cooling the fuel below ignition point.

#### C. VAPOR SUPPRESSION (SEALING)


Prevents release of flammable vapors, preventing re-ignition.

### 2. TYPICAL SYSTEM SCHEMATIC (BLADDER TANK)




**KEY COMPONENTS LIST**

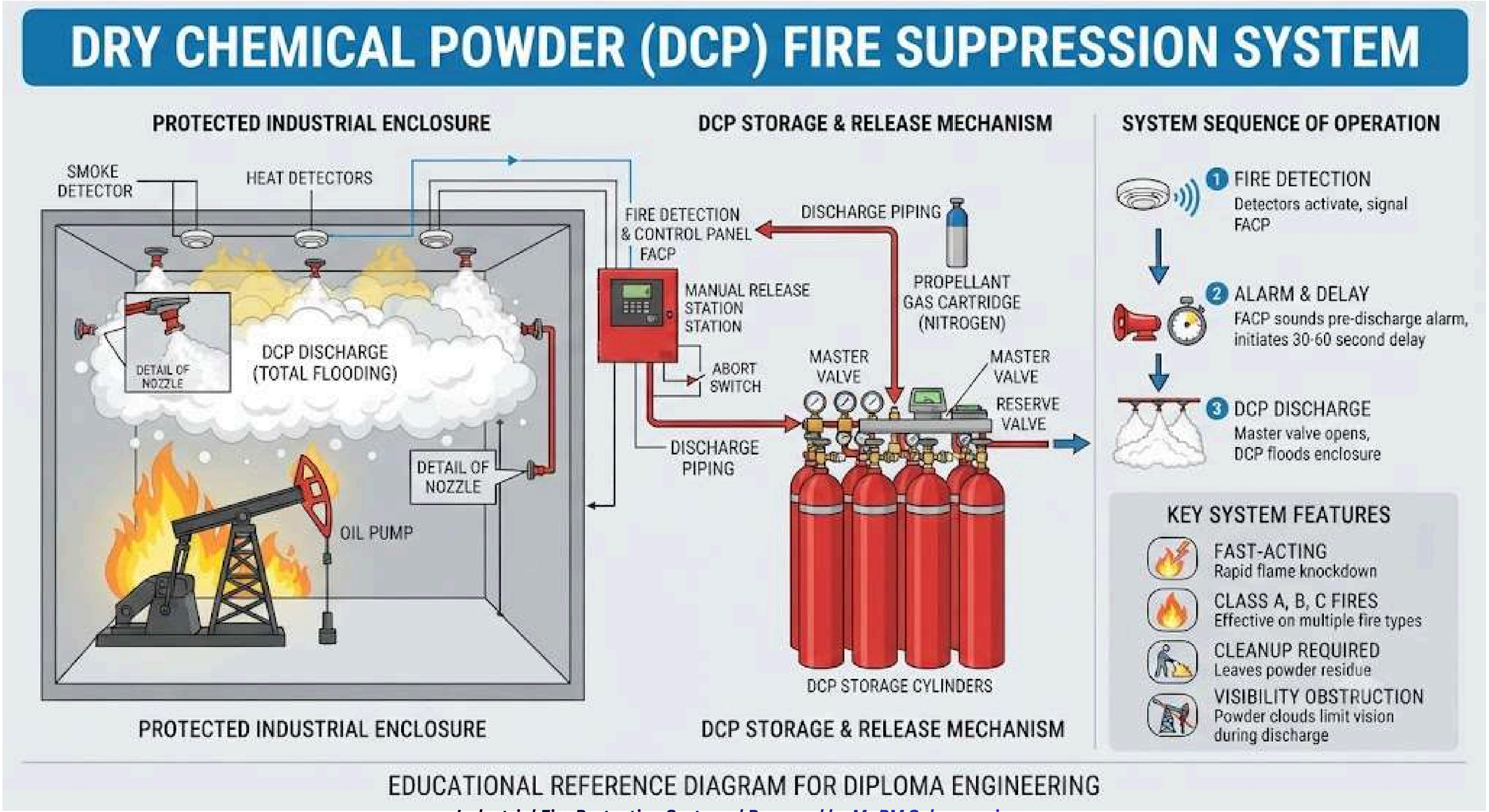
- Foam Concentrate
- Proportioner
- Proportioner
- Deluge Valve
- Foam Maker/Chamber
- Discharge Device

**EDUCATIONAL REFERENCE DIAGRAM FOR FIRE PROTECTION ENGINEERING**

# foam suppression system

- **Extinguishing Mechanism:** Creates a stable blanket of foam that floats on top of flammable liquids, cutting off the oxygen supply and suppressing vapor release.
- **Primary Applications:** Specifically designed for Class B fires involving fuel storage tanks, oil refineries, and chemical facilities.
- **Key Components:** Comprises foam concentrate storage tanks, proportioning systems (mixers), foam chambers, and discharge monitors.
- **Smothering and Sealing:** Provides dual action by smothering the flames and sealing the fuel surface to prevent re-ignition.

# Dry Chemical Powder (DCP) suppression system



# Dry Chemical Powder (DCP) suppression system

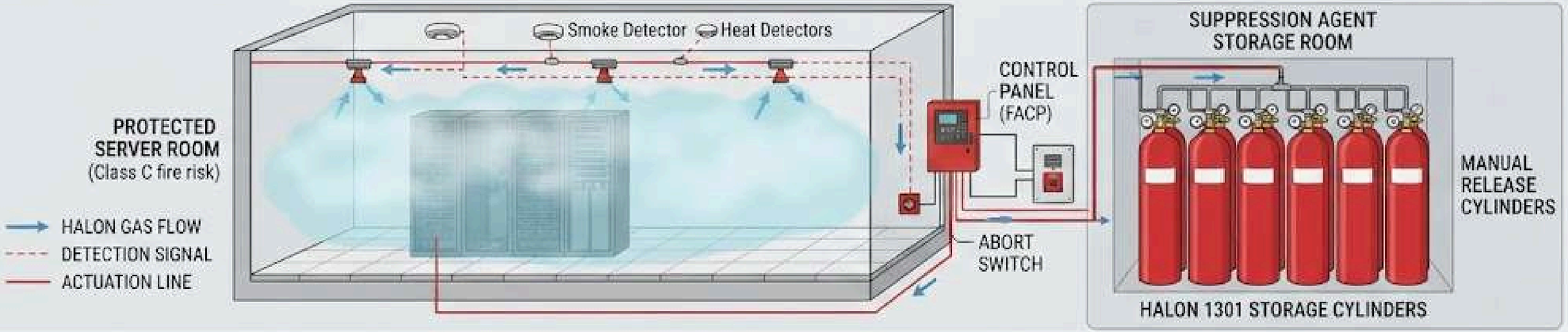
- **Extinguishing Mechanism:** Interrupts the chemical chain reaction of the fire rapidly while blanketing the fuel, making it highly effective against Class A, B, and C fires.
- **Rapid Knockdown:** Delivers an aggressive, fast-acting powder discharge ideal for fast-spreading fuel spills and pressurized gas fires.
- **Key Components:** Storage cylinders for dry powder, propellant gas cartridges (nitrogen/air), piping networks, and discharge nozzles.
- **Cleanup & Visibility Hazard:** Leaves a powdery residue that requires cleanup, and heavy discharge can temporarily obstruct visibility in enclosed areas.

# Halon Suppression System

## HALON TOTAL FLOODING FIRE SUPPRESSION SYSTEM (LEGACY SYSTEM)

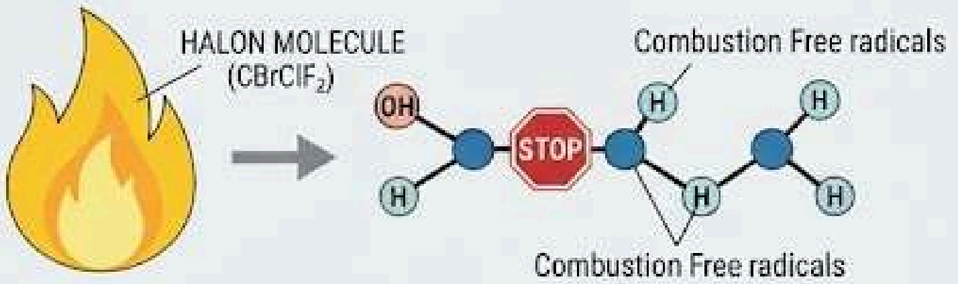
EDUCATIONAL REFERENCE DIAGRAM.

### SECTION 1: SYSTEM SCHEMATIC (Top)




### SECTION 2: MECHANISM OF ACTION

MECHANISM OF EXTINCTION: CHEMICAL CHAIN BREAKER




Halon chemically inhibits the chain reaction of fire by capturing free radicals.

### SECTION 3: KEY FEATURES & ENVIRONMENTAL NOTE

KEY CHARACTERISTICS

- CLEAN AGENT — Residue-free, safe for electronics
- FAST-ACTING — Rapid extinguishment
- NON-CONDUCTIVE — Safe for electrical equipment
- TOTAL FLOODING — Fills the entire room

**ENVIRONMENTAL NOTE & PHASE-OUT**

HALON 1301 PRODUCTION WAS PHASED OUT GLOBALLY UNDER THE MONTREAL PROTOCOL (1987) DUE TO HIGH OZONE DEPLETION POTENTIAL (ODP).

ODP

System shown is for historical and educational reference.
Modern systems use clean agent alternatives (e.g., FM-200, Novec 1230).

# Halon  Suppression System

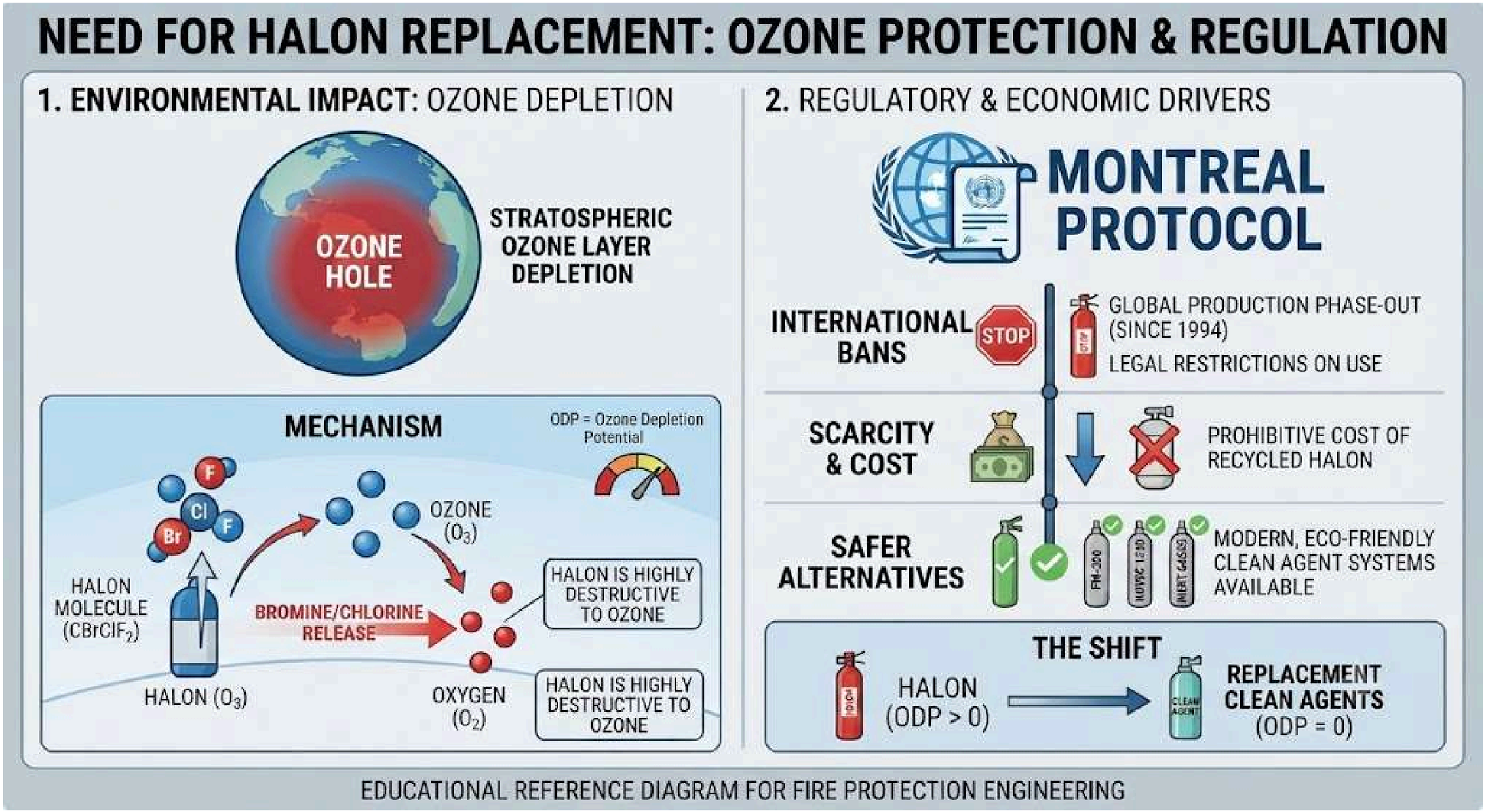
**Extinguishing Mechanism:** Interrupts the chemical chain reaction of combustion rapidly through the release of halogenated hydrocarbon clean agents.

**Residue-Free & Non-Conductive:** Discharges as a gas that leaves no liquid residue, making it safe for sensitive electronic equipment and computer rooms.

**Environmental Phase-Out:** Halon production was globally restricted and phased out under the Montreal Protocol due to its high ozone depletion potential (ODP).

**Modern Replacements:** Superseded in modern industrial facilities by eco-friendly clean agents such as FM-200 (HFC-227ea), Novec 1230, and inert gas systems.

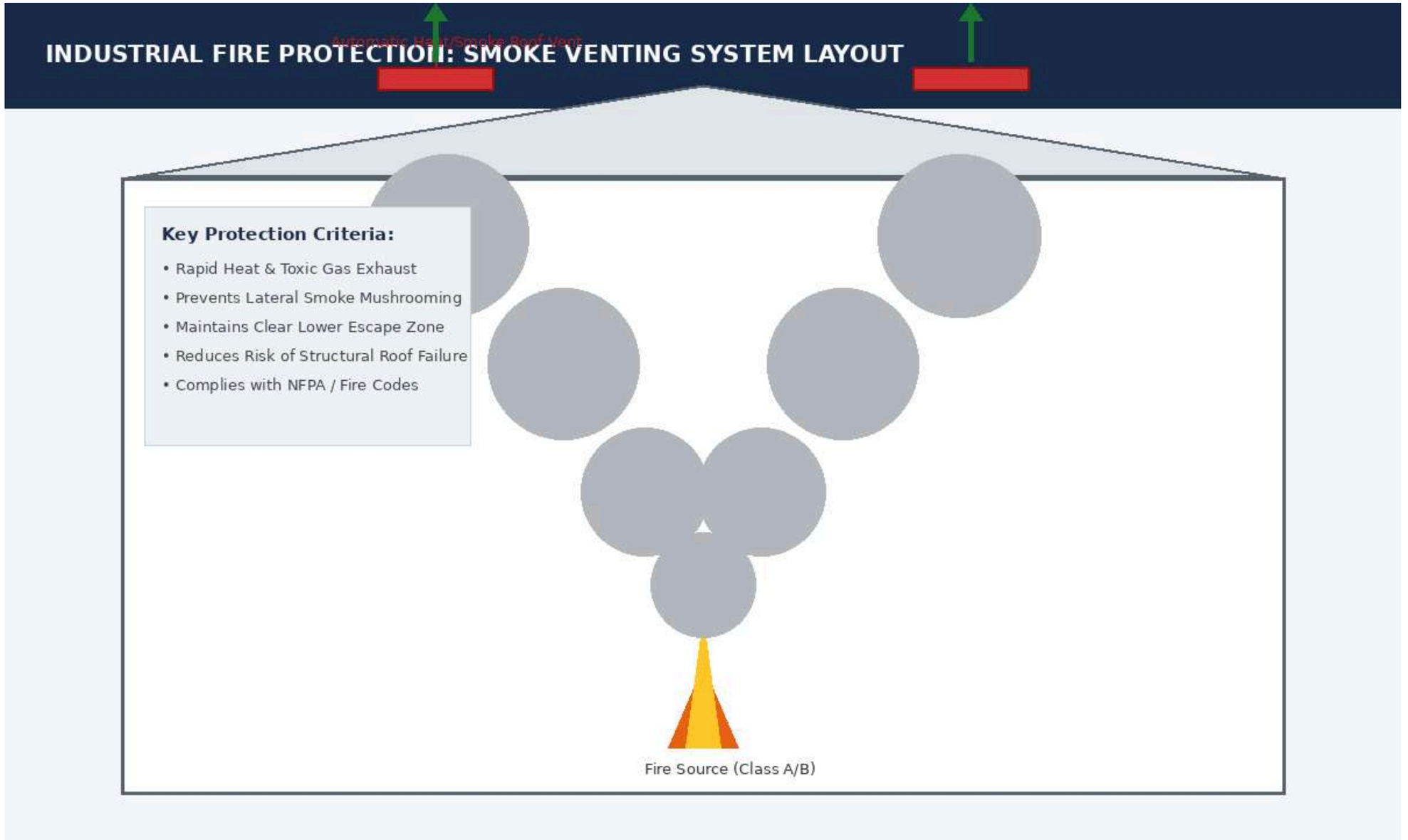
# Need for Halon Replacement



# Need for Halon Replacement

- **Severe Ozone Depletion:** Halons have an extremely high Ozone Depletion Potential (ODP) because their bromine and chlorine content actively destroys stratospheric ozone.
- **International Regulations & Bans:** Global production and consumption were legally banned and phased out under the **Montreal Protocol**.
- **Scarcity and Escalating Costs:** Recycled or existing "banked" supplies of Halon have become severely scarce and financially prohibitive to maintain.
- **Availability of Safer Alternatives:** Modern, eco-friendly clean agents (such as FM-200, Novec 1230, and inert gases) provide equally effective fire suppression without environmental damage.

# smoke venting.



## smoke venting.

- **Removal of Heat and Smoke:** Designed to extract hot gases, toxic smoke, and heat build-up from a burning building to maintain visibility and breathable air.
- **Structural Protection:** Prevents premature structural collapse by venting intense thermal energy away from the building's roof and load-bearing walls.
- **Facilitates Firefighting Operations:** Improves safety and visibility for emergency response teams entering the facility to locate and extinguish the fire.
- **Types of Vents:** Utilizes either natural gravity smoke vents (using thermal buoyancy through roof hatches) or mechanical powered exhaust fans.

# smoke venting.

## UNDERSTANDING THE NEED FOR SMOKE VENTING IN BUILDINGS

### WITHOUT SMOKE VENTING (HIGH RISK)

- Traps Toxic Gases: Smoke and lethal gases accumulate rapidly, blocking visibility.
- Severe Heat Buildup: Extreme thermal energy spreads laterally under roof.
- Structural Collapse Risk: High heat weakens steel/concrete roof structures.
- Hinders Firefighting: Makes entry & rescue operations extremely hazardous.

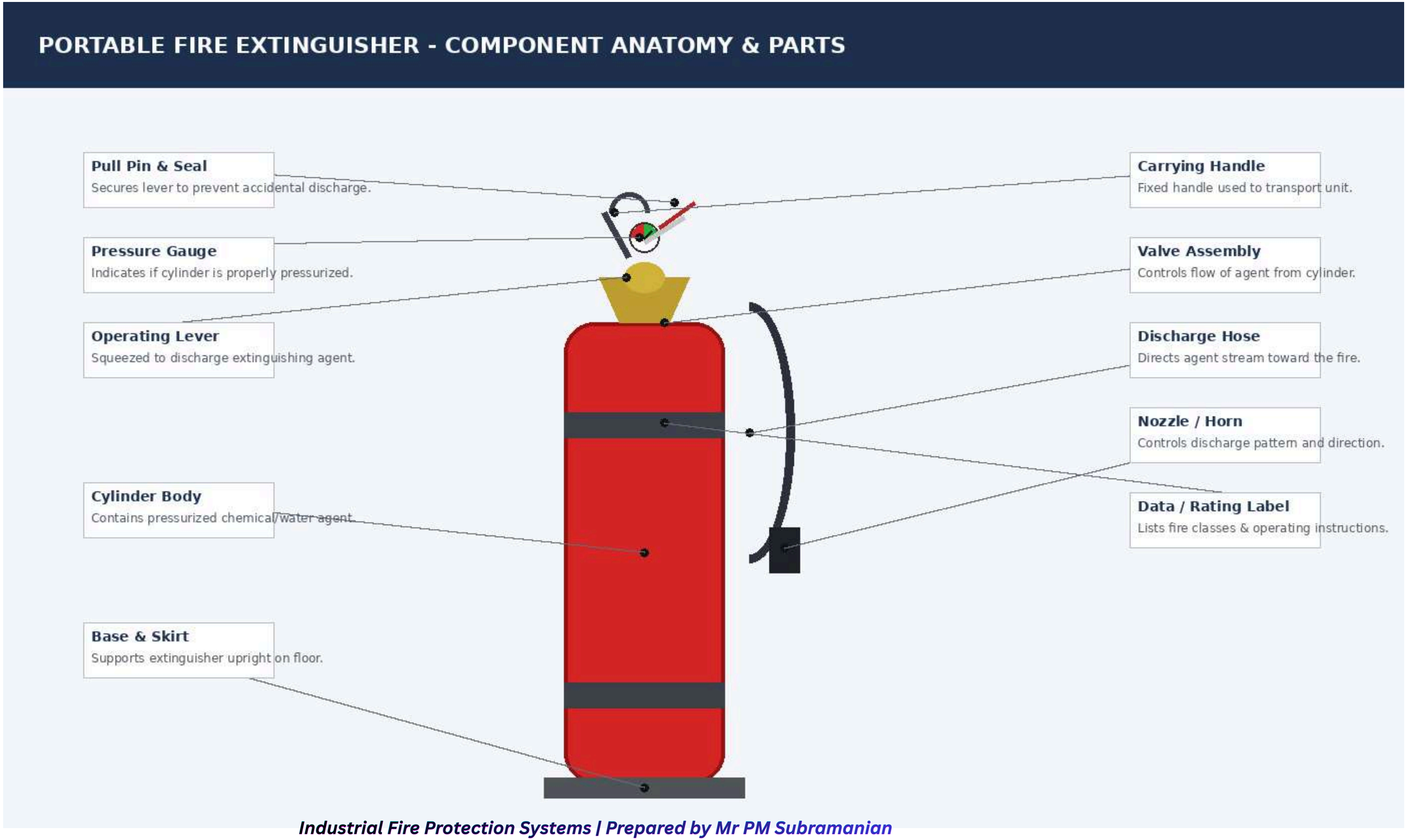
### WITH SMOKE VENTING (CONTROLLED SAFETY)

- Efficient Heat & Smoke Removal: Extracts hot toxic smoke outdoors immediately.
- Preserves Visibility & Air: Maintains clearer escape and evacuation paths.
- Protects Structure: Vents thermal energy outward, preventing roof collapse.
- Aids Emergency Responders: Provides safer conditions for firefighting teams.

# Portable Extinguishers

- **Primary First-Response Tool**: Portable extinguishers are the first line of defense, designed for early-stage or incipient fires in industrial facilities before professional fire services arrive.
- **Fire Classifications Compatibility**: Industrial units must be matched to specific workplace fire classes:
  - **Class A**: Ordinary combustibles (wood, paper, textiles).
  - **Class B**: Flammable liquids and gases (solvents, oils, paints).
  - **Class C**: Energized electrical equipment.
  - **Class D**: Combustible metals (magnesium, titanium, sodium).
  - **Class K**: Cooking oils and fats (commercial kitchens).

# Portable Extinguishers



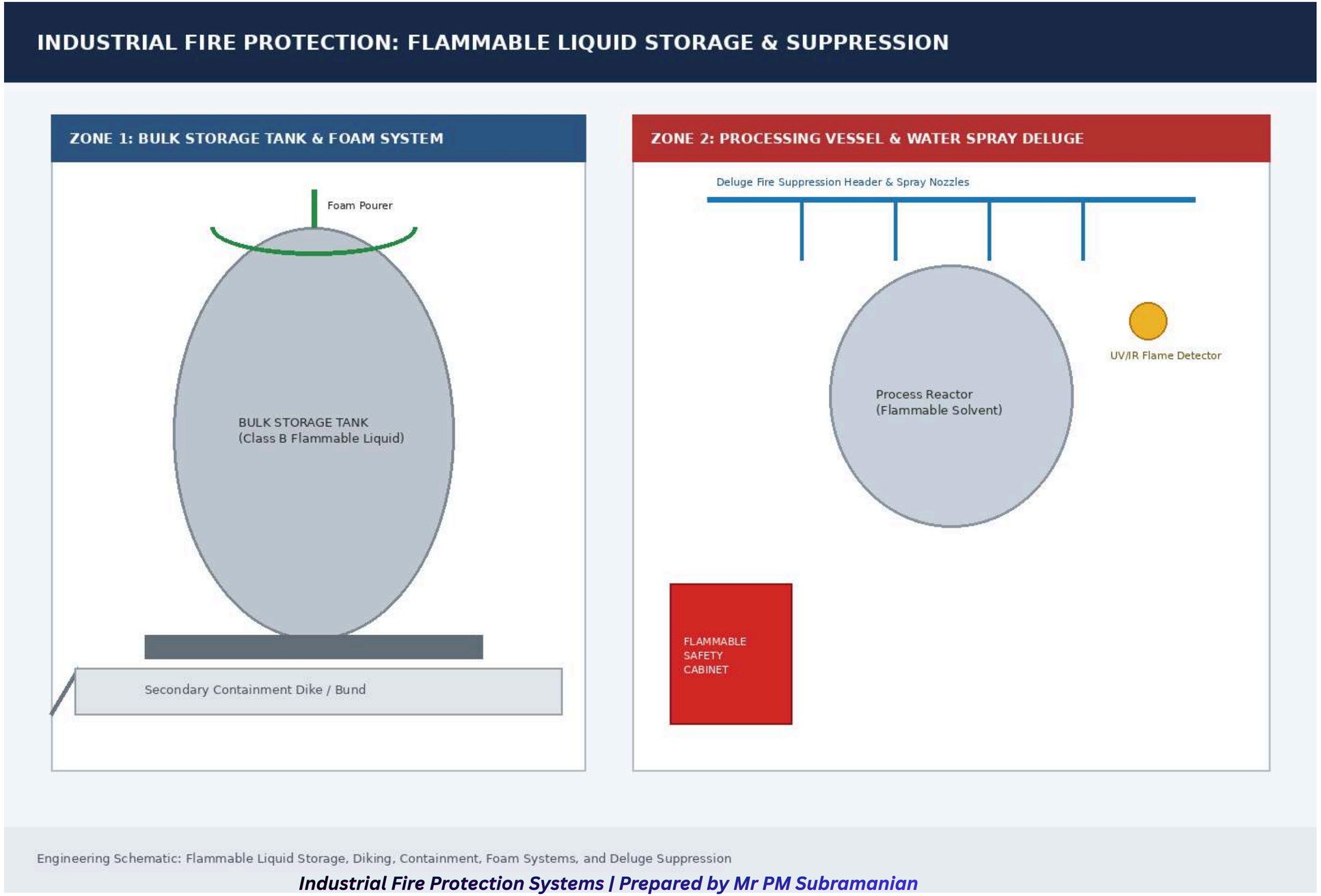
# Portable Extinguishers

- **Strategic Placement and Accessibility**: Extinguishers must be positioned along normal paths of travel, highly visible, and mounted securely at accessible heights (typically within 30 to 50 feet travel distance depending on hazard severity).
- **Inspection, Testing, and Maintenance (ITM)**: Regular checks are mandatory, including monthly visual inspections for pressure and damage, annual professional maintenance, and periodic hydrostatic testing to comply with NFPA and industrial safety standards.
- **Personnel Training**: Workers must be adequately trained on the PASS technique (Pull, Aim, Squeeze, Sweep) and educated on when it is safe to fight a fire versus when to immediately evacuate.

# Flammable Liquids

- **Hazard Severity:** Flammable liquids (Class B hazards) present severe industrial risks due to their low flash points, rapid vaporization, and high heat release rates, which can quickly lead to explosions or uncontained pool fires.
- **Storage and Containment:** Industrial facilities must store flammable liquids in approved safety containers, dedicated flammable liquid storage cabinets, or engineered bulk storage tanks equipped with proper venting and overflow protection.
- **Ventilation and Vapor Control:** Adequate mechanical ventilation systems are essential in areas handling flammable liquids to prevent hazardous vapor concentrations from reaching their lower explosive limit (LEL).

# Flammable Liquids




Engineering Schematic: Flammable Liquid Storage, Diking, Containment, Foam Systems, and Deluge Suppression

# Flammable Liquids

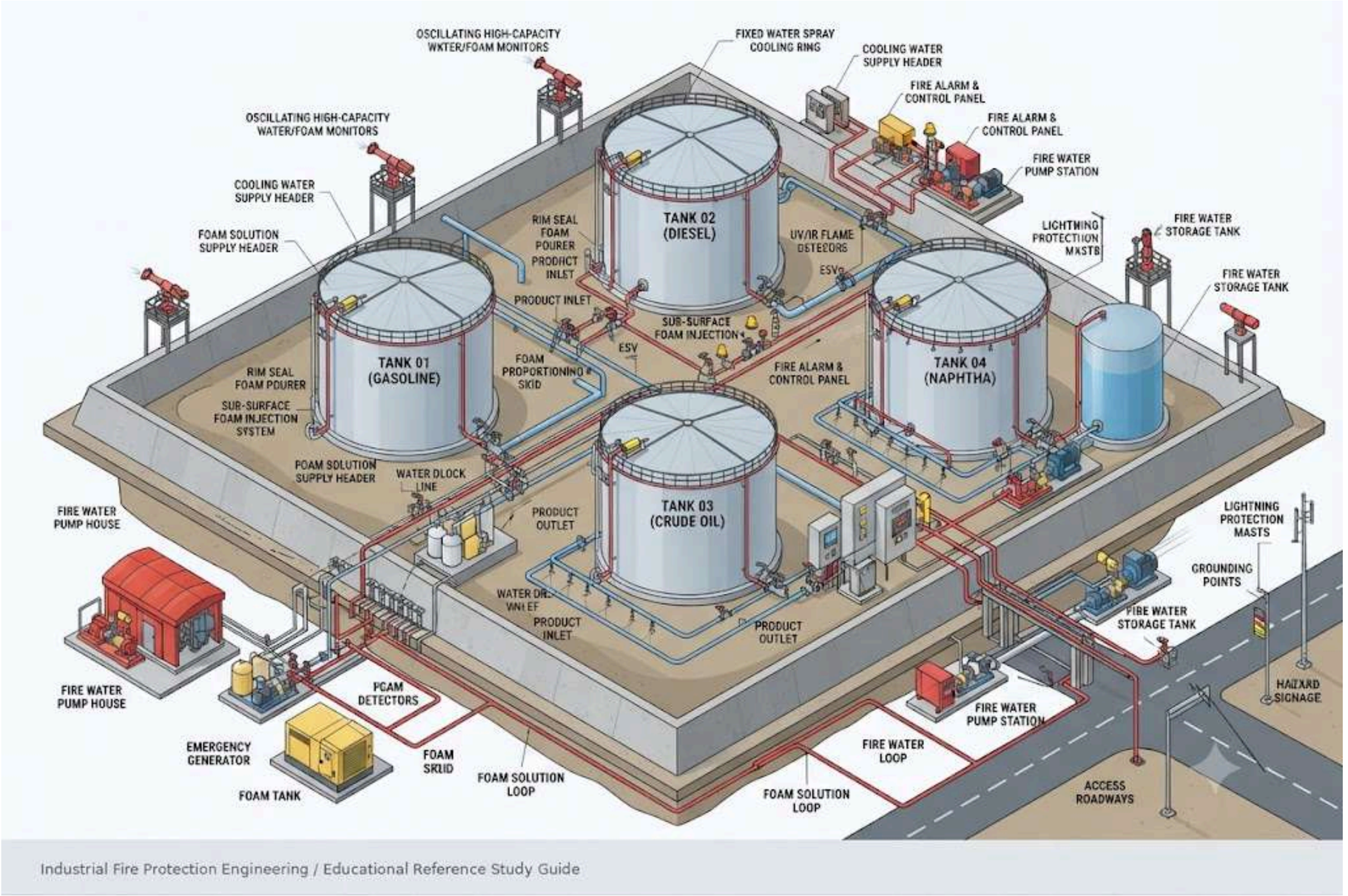
- **Fire Suppression Systems**: Water alone is often ineffective or dangerous for flammable liquid fires; systems utilize specialized agents such as foam (AFFF), dry chemical, carbon dioxide ($CO_2$), or clean agent total flooding systems.
- **Ignition Source Control**: Strict hazardous area classification and ignition source controls—including explosion-proof electrical fittings, static electricity grounding/bonding, and hot-work permits—are mandatory.
- **Secondary Containment**: Dikes, drainage channels, and containment berms must be installed around storage and processing areas to prevent the spread of burning liquid to other parts of the facility.

# Tank Farms

Here are the important points regarding **Tank Farms in Industrial Fire Protection Systems**:

- **High-Hazard Environment**: Tank farms store massive volumes of flammable and combustible liquids, presenting severe risks of large-scale pool fires, vapor cloud explosions, and boil-overs.
- **Secondary Containment (Dikes/Bunds)**: Engineered walls or berms surrounding tanks to contain spills and prevent burning liquids from spreading to adjacent areas.
- **Fixed Fire Suppression Systems**: Specialized fixed foam systems (such as top pourers, subsurface injection, or foam-water deluge) designed to blanket and smother liquid surface fires.

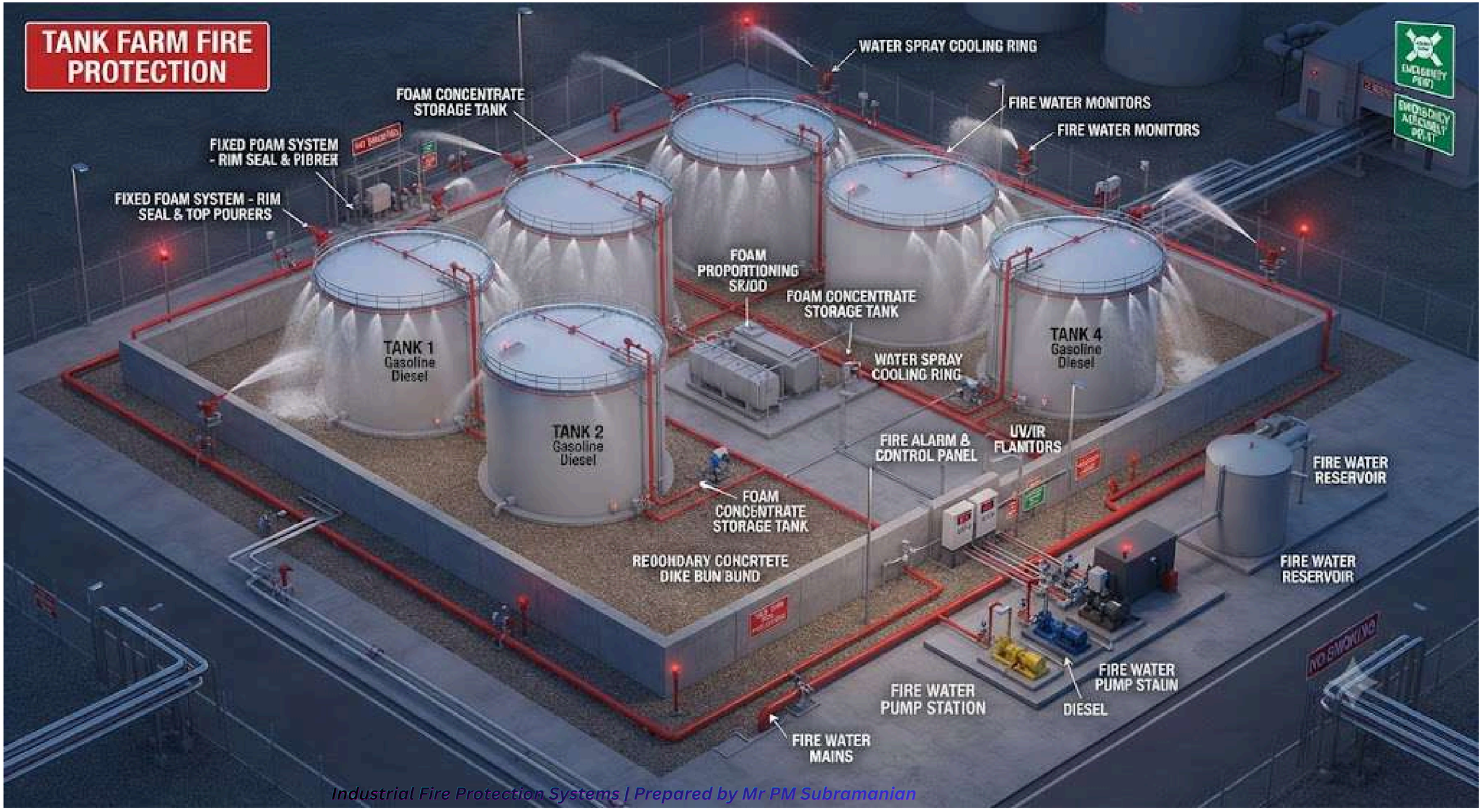
# Tank Farms


OSCILLATING HIGH-CAPACITY WATER/FOAM MONITORS
FIXED WATER SPRAY COOLING RING
COOLING WATER SUPPLY HEADER
FIRE ALARM & CONTROL PANEL
FIRE ALARM & CONTROL PANEL
FIRE WATER PUMP STATION
OSCILLATING HIGH-CAPACITY WATER/FOAM MONITORS
COOLING WATER SUPPLY HEADER
FOAM SOLUTION SUPPLY HEADER
RIM SEAL FOAM POURER
PRODUCT INLET
TANK 02 (DIESEL)
UV/IR FLAME DETECTORS
ESV
LIGHTNING PROTECTION MASTS
FIRE WATER STORAGE TANK
FIRE WATER STORAGE TANK
PRODUCT INLET
SUB-SURFACE FOAM INJECTION
ESV
TANK 01 (GASOLINE)
FOAM PROPORTIONING SKID
FIRE ALARM & CONTROL PANEL
TANK 04 (NAPHTHA)
RIM SEAL FOAM POURER
SUB-SURFACE FOAM INJECTION SYSTEM
FOAM SOLUTION SUPPLY HEADER
WATER DLOCK LINE
TANK 03 (CRUDE OIL)
FIRE WATER PUMP HOUSE
PRODUCT OUTLET
LIGHTNING PROTECTION MASTS
GROUNDING POINTS
WATER DR- VALVE
PRODUCT INLET
PRODUCT OUTLET
FIRE WATER STORAGE TANK
FIRE WATER PUMP HOUSE
FOAM DETECTORS
HAZARD SIGNAGE
EMERGENCY GENERATOR
FOAM SKID
FIRE WATER PUMP STATION
FIRE WATER LOOP
FOAM SOLUTION LOOP
FOAM TANK
FOAM SOLUTION LOOP
ACCESS ROADWAYS
Industrial Fire Protection Engineering / Educational Reference Study Guide

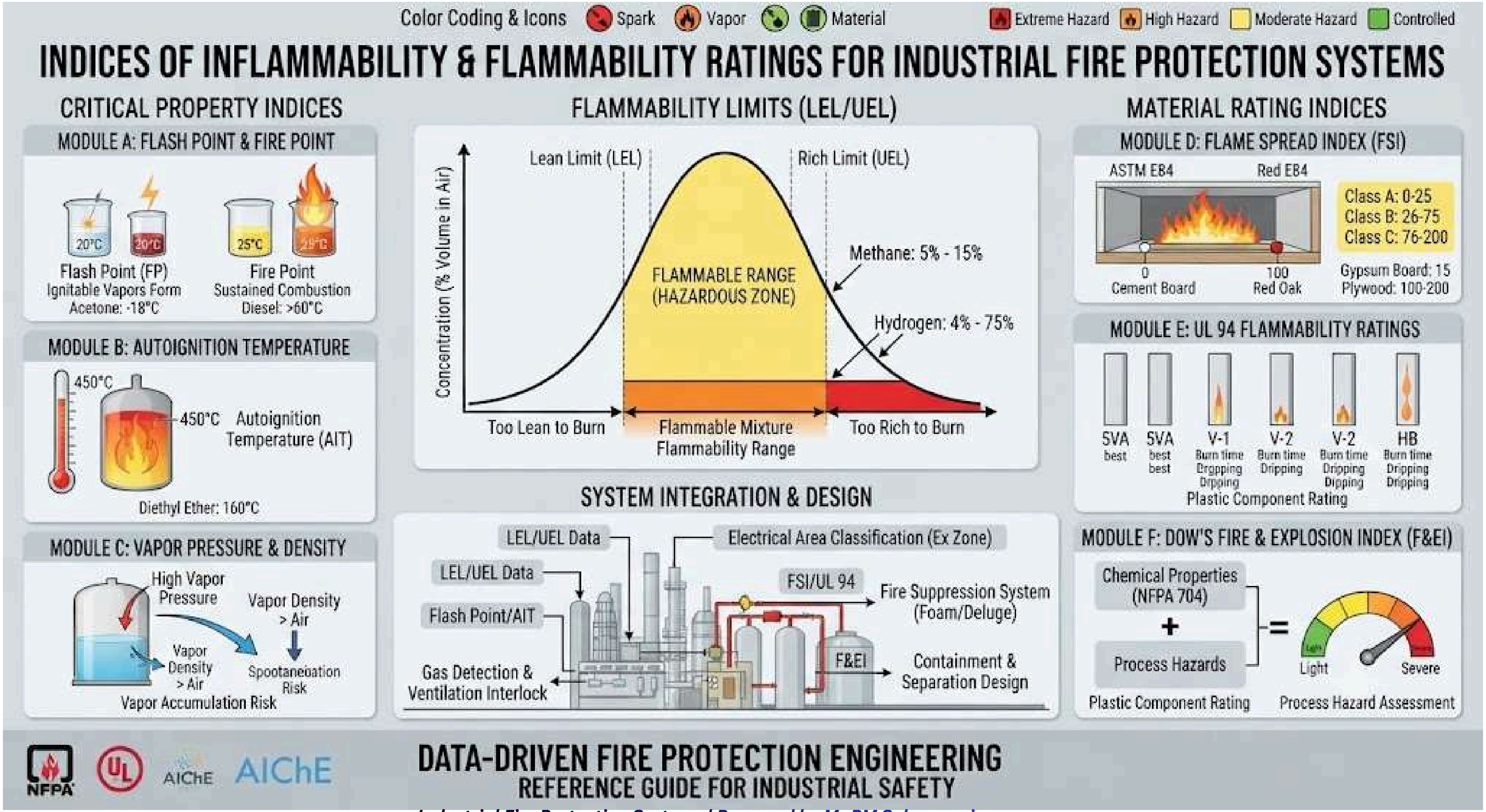
# Tank Farms

- **Tank Cooling Systems**: Fixed water spray rings, deluge systems, and high-capacity water monitors used to cool adjacent tanks and protect them from radiant heat exposure, preventing structural collapse or rupture.
- **Separation and Spacing**: Strict adherence to engineering standards (such as NFPA 30) regarding minimum distances between tanks to mitigate thermal radiation and fire propagation risks.
- **Detection and Alarm Integration**: Rapid-response flame, heat, and flammable gas detection systems tied directly to emergency shutdown valves (ESVs) and automated fire suppression activation.

# Tank Farms


TANK FARM FIRE PROTECTION
WATER SPRAY COOLING RING
FOAM CONCENTRATE STORAGE TANK
FIRE WATER MONITORS
FIRE WATER MONITORS
FIXED FOAM SYSTEM - RIM SEAL & PIBRER
FIXED FOAM SYSTEM - RIM SEAL & TOP POURERS
FOAM PROPORTIONING SKIDD
FOAM CONCENTRATE STORAGE TANK
WATER SPRAY COOLING RING
TANK 1 Gasoline Diesel
TANK 2 Gasoline Diesel
TANK 4 Gasoline Diesel
FIRE ALARM & CONTROL PANEL
UV/IR FLAMTORS
FIRE WATER RESERVOIR
FOAM CONCENTRATE STORAGE TANK
REOONDARY CONCRTETE DIKE BUN BUND
FIRE WATER RESERVOIR
FIRE WATER PUMP STALN
FIRE WATER PUMP STATION
DIESEL
FIRE WATER MAINS

# Indices of Inflammability



# Indices of Inflammability

- **Dow's Fire and Explosion Index (F&EI)**: A quantitative risk assessment system that assigns numerical scores to industrial processes and chemicals based on flammability, combustibility, vapor pressure, autoignition temperature, and reactivity to determine required safety and containment measures.
- **Flame Spread Index (FSI)**: A numerical classification derived from standard tunnel tests (such as ASTM E84) that measures how rapidly flames propagate across structural building materials and interior finishes, ranging from Class A (slowest spread) to higher hazard ratings.
- **Flash Point and Autoignition Temperature**: Core property indices that quantify the minimum temperature at which a substance releases ignitable vapors or spontaneously combusts without an external ignition source, guiding safe storage and electrical classification.

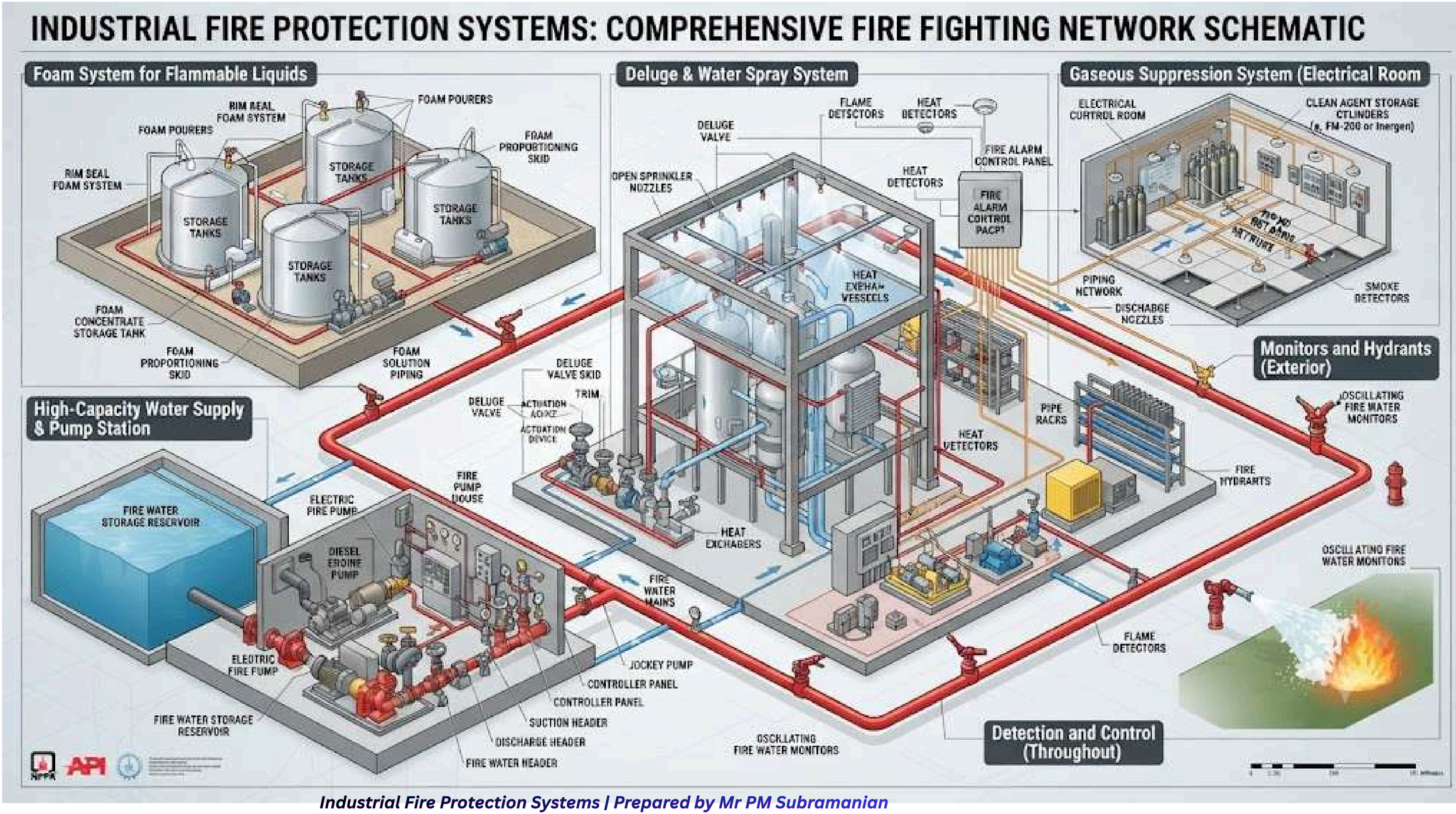
# Indices of Inflammability

- **Explosive Limits (LEL and UEL)**: Lower and Upper Explosive Limits that define the concentration boundaries of flammable gases and vapors in the air, dictating the design of mechanical ventilation, vapor control, and automated gas detection interlocks.
- **UL 94 Flammability Ratings**: Standardized indices evaluating the burning rates and self-extinguishing properties of plastics and electrical components used in industrial equipment, ranging from slow-burning (HB) to high-performance self-extinguishing ratings (V-0, 5VA).

# Fire Fighting Systems.

- **High-Capacity Water Supply & Pump Stations:** Dedicated fire water storage reservoirs backed by heavy-duty diesel and electric pump assemblies to guarantee continuous pressure and high-flow delivery during emergencies.
- **Deluge and Water Spray Systems:** Open-nozzle networks tied to automated detection that flood high-hazard process areas simultaneously to suppress fires and provide critical cooling to surrounding equipment.
- **Specialized Foam Systems:** Engineered foam proportioning skids, top pourers, and subsurface injection systems designed specifically to blanket and extinguish Class B flammable liquid and tank farm fires.

# Fire Fighting Systems.




*Industrial Fire Protection Systems | Prepared by Mr PM Subramanian*

# Fire Fighting Systems.

- **Gaseous Total Flooding Systems**: Clean agent or inert gas suppression networks deployed in enclosed, high-value assets (such as electrical control rooms and data centers) to extinguish fires without water damage or residue.
- **Monitors and Hydrants**: Strategically positioned manual or oscillating water/foam monitors capable of delivering high-velocity, long-range streams to protect large outdoor structures and storage zones.
- **Detection & Control Integration**: Automated emergency networks linking UV/IR flame, heat, and gas detectors directly to fire alarm control panels (FACPs) and emergency shutdown valves (ESVs) for immediate response.

# Building fire safety

**Compartmentation**: Division of industrial and commercial buildings into fire-resistant compartments using fire walls, fire doors, and dampers to restrict smoke and fire propagation.

**Means of Egress**: Clearly marked, unobstructed exit routes, corridors, stairwells, and emergency exit doors designed to ensure rapid evacuation of personnel during a fire incident.

**Structural Fire Protection**: Application of fire-resistant coatings, encasements, and construction materials to steel and concrete columns to maintain load-bearing integrity under high temperatures.

# Building fire safety

# Building fire safety

**Smoke Management Systems:** Engineered mechanical smoke exhaust systems and natural smoke vents designed to keep evacuation pathways clear of toxic gases and heat.

**Emergency Lighting and Signage:** Battery-backed emergency exit lighting and illuminated escape route signs that remain operational during a total power failure.

**Active Fire Suppression & Detection:** Integration of automatic sprinkler networks, fire alarm control panels, smoke detectors, and manual call points throughout the building framework.

# Objectives of fire safe building design

## Objectives of Fire-Safe Building Design

Fire-safe building design integrates architecture, engineering, and active/passive safety systems to minimize risk and protect human life and property. The primary objectives include:

- **Life Safety**: Ensuring the highest priority is given to protecting occupants, preventing injury, and allowing safe, unobstructed evacuation during an emergency.
- **Structural Integrity**: Maintaining the load-bearing capacity of columns, beams, floors, and walls under extreme thermal stress to prevent premature structural collapse.
- **Fire and Smoke Containment**: Restricting the spread of fire and toxic smoke to the point of origin through effective compartmentation, fire-resistant walls, and dampers.

# Objectives of fire safe building design

# Objectives of fire safe building design

**Property Protection**: Minimizing physical damage to the building, industrial machinery, and high-value assets stored within the facility.

**Business Continuity**: Reducing operational downtime and enabling rapid recovery and resumption of business functions after an incident.

**Environmental Protection**: Preventing uncontained hazardous runoff, toxic chemical spills, or heavy smoke emissions from impacting the surrounding community and ecosystem.

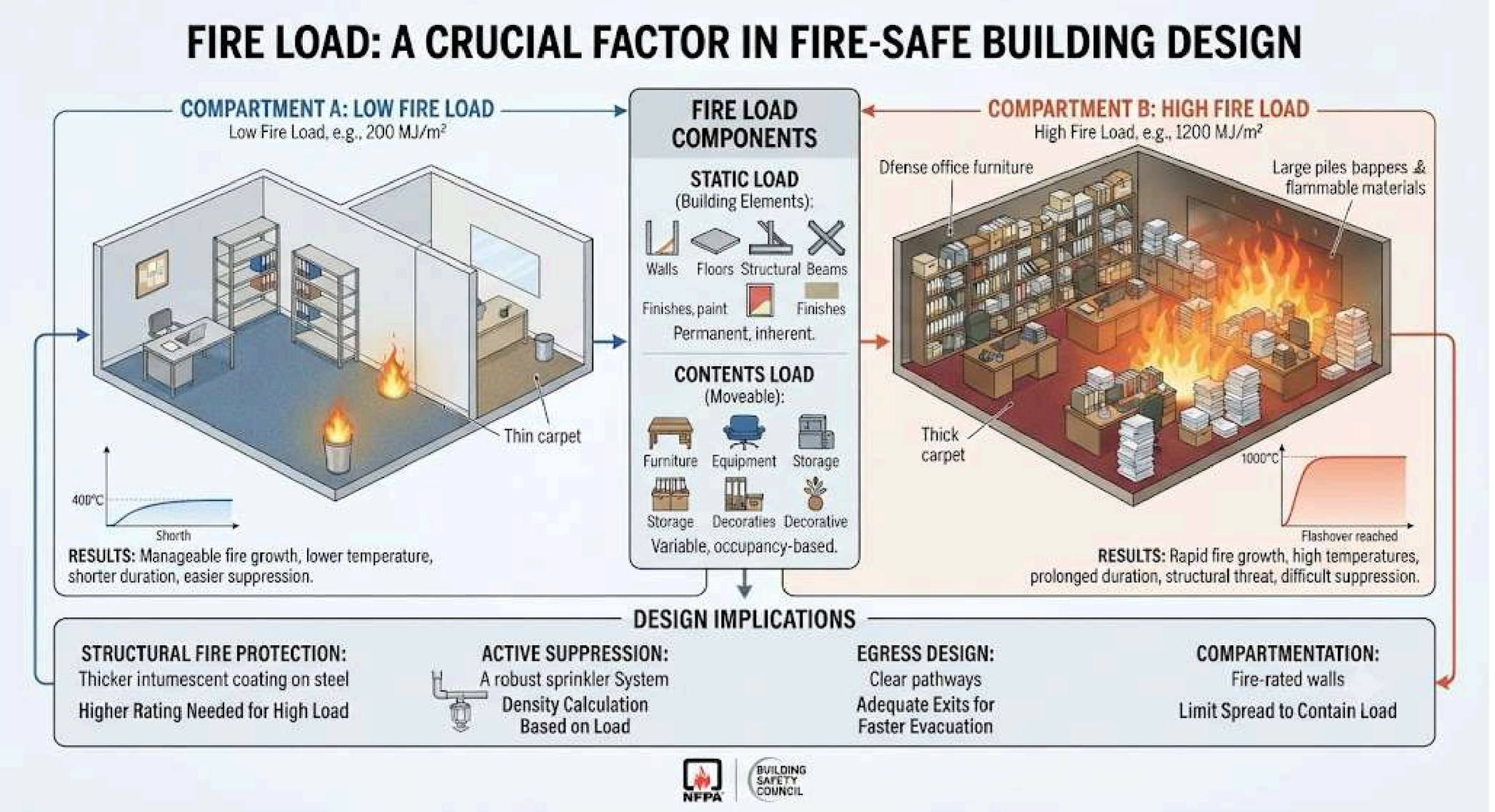
**Firefighter Access and Safety**: Providing secure entry points, reliable water supply networks, and safe staging areas for emergency response teams.

# Fire load

Here are the important points regarding **Fire Load in Industrial Fire Protection Systems**:

- **Definition & Measurement**: The total quantity of combustible materials in a given area expressed as its calorific energy output, typically measured in megajoules per square meter ($MJ/m^2$).
- **Impact on Suppression System Design**: Directly determines the required water application density, sprinkler system design criteria, and extinguishing agent volume (such as foam or water supply).
- **Static vs. Contents Load**: Differentiates between permanent structural combustibles (static) and variable industrial inventory, raw materials, and machinery (contents).

# Fire load


FIRE LOAD: A CRUCIAL FACTOR IN FIRE-SAFE BUILDING DESIGN
COMPARTMENT A: LOW FIRE LOAD
Low Fire Load, e.g., 200 MJ/m²
Thin carpet
400°C
Shorth
RESULTS: Manageable fire growth, lower temperature, shorter duration, easier suppression.
FIRE LOAD COMPONENTS
STATIC LOAD
(Building Elements):
Walls
Floors
Structural Beams
Finishes, paint
Finishes
Permanent, inherent.
CONTENTS LOAD
(Moveable):
Furniture
Equipment
Storage
Storage
Decoraties
Decorative
Variable, occupancy-based.
COMPARTMENT B: HIGH FIRE LOAD
High Fire Load, e.g., 1200 MJ/m²
Dfense office furniture
Large piles bappers & flammable materials
Thick carpet
1000°C
Flashover reached
RESULTS: Rapid fire growth, high temperatures, prolonged duration, structural threat, difficult suppression.
DESIGN IMPLICATIONS
STRUCTURAL FIRE PROTECTION:
Thicker intumescent coating on steel
Higher Rating Needed for High Load
ACTIVE SUPPRESSION:
A robust sprinkler System
Density Calculation
Based on Load
EGRESS DESIGN:
Clear pathways
Adequate Exits for Faster Evacuation
COMPARTMENTATION:
Fire-rated walls
Limit Spread to Contain Load
NFPA
BUILDING SAFETY COUNCIL

# Fire load

- **Structural Fire Resistance Ratings (FRR)**: Higher fire loads dictate thicker fire-resistant coatings and higher structural ratings for steel and concrete to prevent premature collapse during a prolonged blaze.
- **Hazard Categorization & Zoning**: Serves as a core input for industrial risk assessment tools (like Dow's F&EI) to classify operational zones by severity and configure automated safety interlocks.

# Fire Resistant Material and Fire Testing

## Fire-Resistant Materials

- **Intumescent Coatings**: Reactive paints applied to structural steel that swell up to 50 times their thickness when exposed to high heat, creating an insulating carbon char layer to maintain load-bearing integrity.
- **Cementitious Fireproofing**: Spray-applied mortar, mineral fiber, or gypsum-based mixtures used to protect steel columns, beams, and vessels against thermal shock and premature collapse.
- **Non-Combustible Structural Elements**: Heavy concrete, brickwork, and specialized masonry utilized to build robust fire walls, blast walls, and secondary containment structures.
- **Fire Doors and Dampers**: Automated or thermally activated physical barriers installed across openings and HVAC ductwork to maintain compartmentation integrity and block smoke propagation.

# Fire Resistant Material and Fire Testing

# Fire Resistant Material and Fire Testing

## Standardized Fire Testing

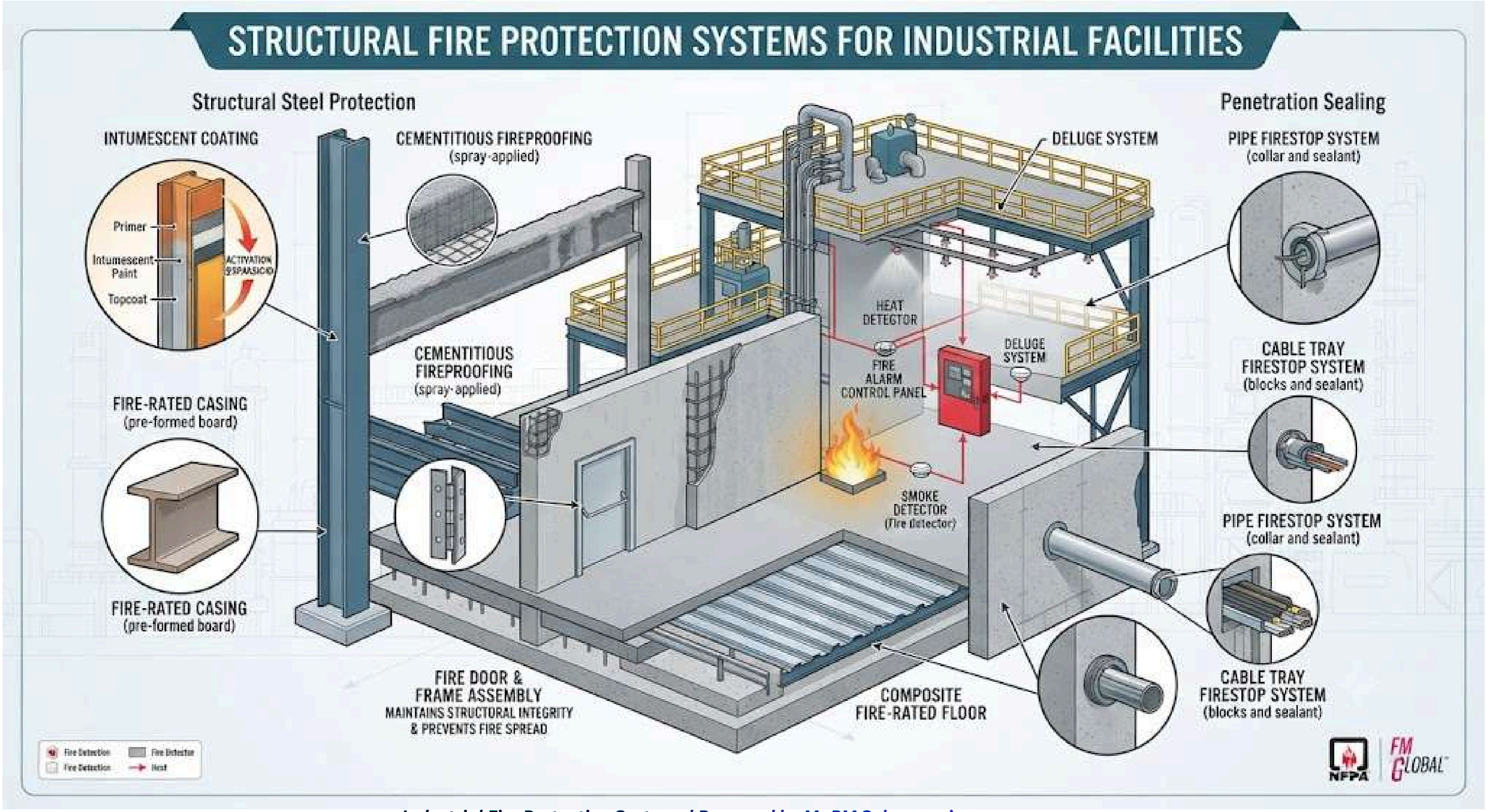
- **ASTM E119 / ISO 834 (Furnace Tests):** Standardized fire endurance tests where structural assemblies, walls, and columns are subjected to a controlled high-temperature furnace curve to determine their Fire Resistance Rating (FRR) in hours.
- **ASTM E84 (Steiner Tunnel Test):** Evaluates the surface burning characteristics of building interior finishes and insulation materials to determine their Flame Spread Index (FSI) and Smoke Developed Index (SDI).
- **UL 94 Flammability Testing:** Evaluates the ignition resistance, burning rate, and self-extinguishing properties of plastic and rubber components used in industrial enclosures and electrical equipment.

# Fire Resistant Material and Fire Testing

# Structural Fire Protection

- **Load-Bearing Integrity**: Designing and protecting structural elements (columns, beams, and trusses) so they maintain their weight-bearing capacity under extreme thermal stress, preventing catastrophic industrial collapse.
- **Passive Fireproofing Materials**: Utilizing spray-applied cementitious mortars, mineral fiber boards, and reactive intumescent coatings that expand to insulate steel frameworks against rapid heat absorption.
- **Fire Resistance Ratings (FRR)**: Ensuring building components meet standardized endurance hours (such as 2, 3, or 4-hour ratings tested via ASTM E119/ISO 834) determined by the facility's fire load and hazard classification.

# Structural Fire Protection



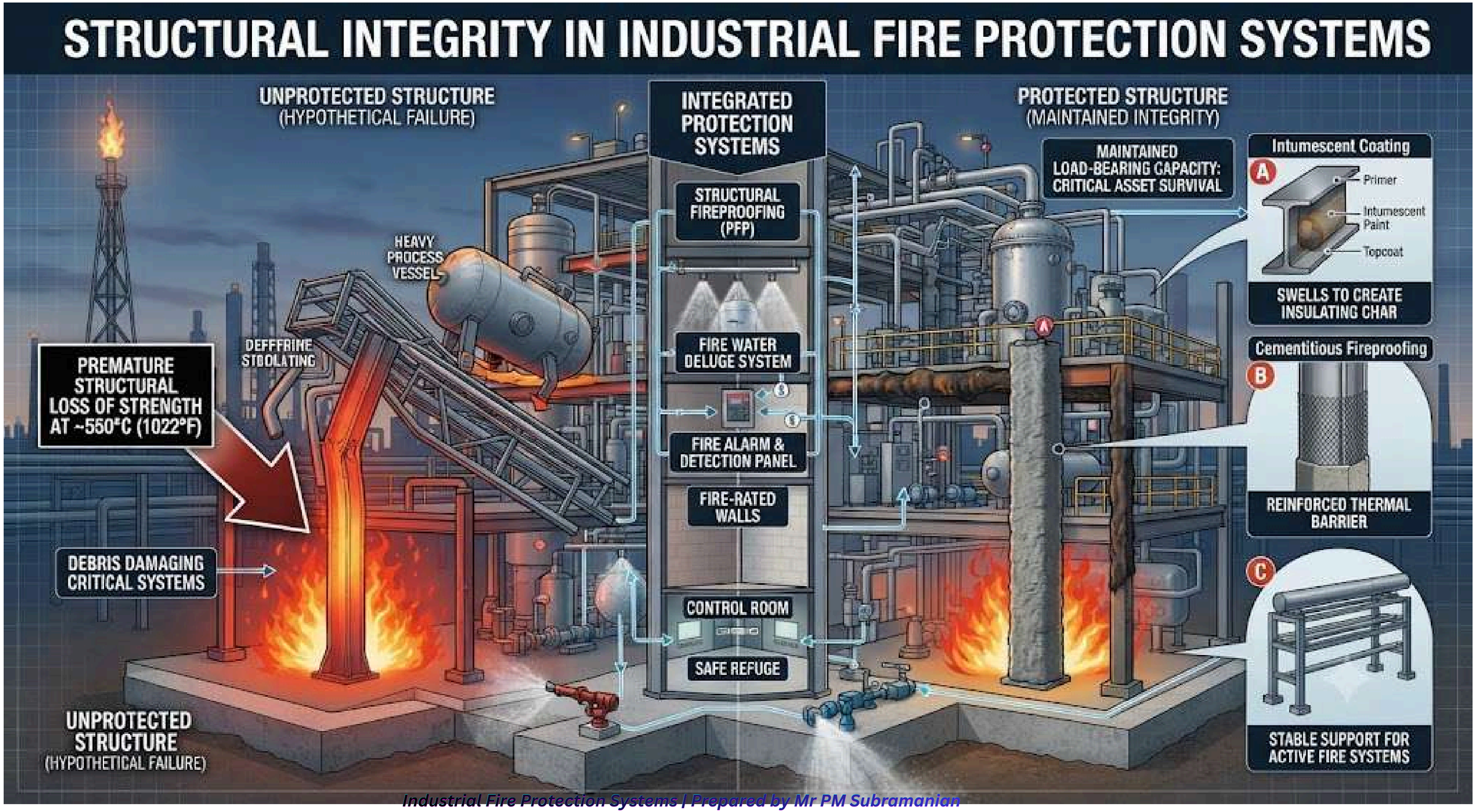
# Structural Fire Protection

- **Heavy Concrete & Masonry Assemblies:** Constructing robust reinforced concrete walls, blast-resistant fire walls, and secondary containment structures to physically isolate high-risk process units and prevent fire spread.
- **Penetration Sealing (Firestops):** Installing certified firestop seals, wraps, and automated dampers around cable trays, pipe racks, and ductwork where they breach fire-rated structural boundaries.
- **Layered Defense Integration:** Acting as the permanent, maintenance-free backbone of safety that buys crucial time for safe personnel evacuation and the effective operation of active suppression systems.

# Structural Integrity

- **Load-Bearing Capacity Under Thermal Stress:** The fundamental capability of structural columns, beams, trusses, and floor slabs to support dead and live industrial loads during extreme fire exposure without failing.
- **Prevention of Premature Thermal Collapse:** Mitigating the rapid loss of mechanical strength in structural carbon steel (which loses roughly 50% of its load-bearing capacity at around 550°C) using thermal barriers.
- **Synergy with Passive Fire Protection (PFP):** Maintaining structural stability through the application of intumescent paints, cementitious spray fireproofing, and pre-formed board casings that insulate the load-bearing framework.

# Structural Integrity



# Structural Integrity

**Support for Active Fire Infrastructure:** Ensuring the structural skeleton remains stable enough to prevent the collapse of heavy suspended or rooftop fire protection assets, such as pipe racks, deluge headers, and water tanks.

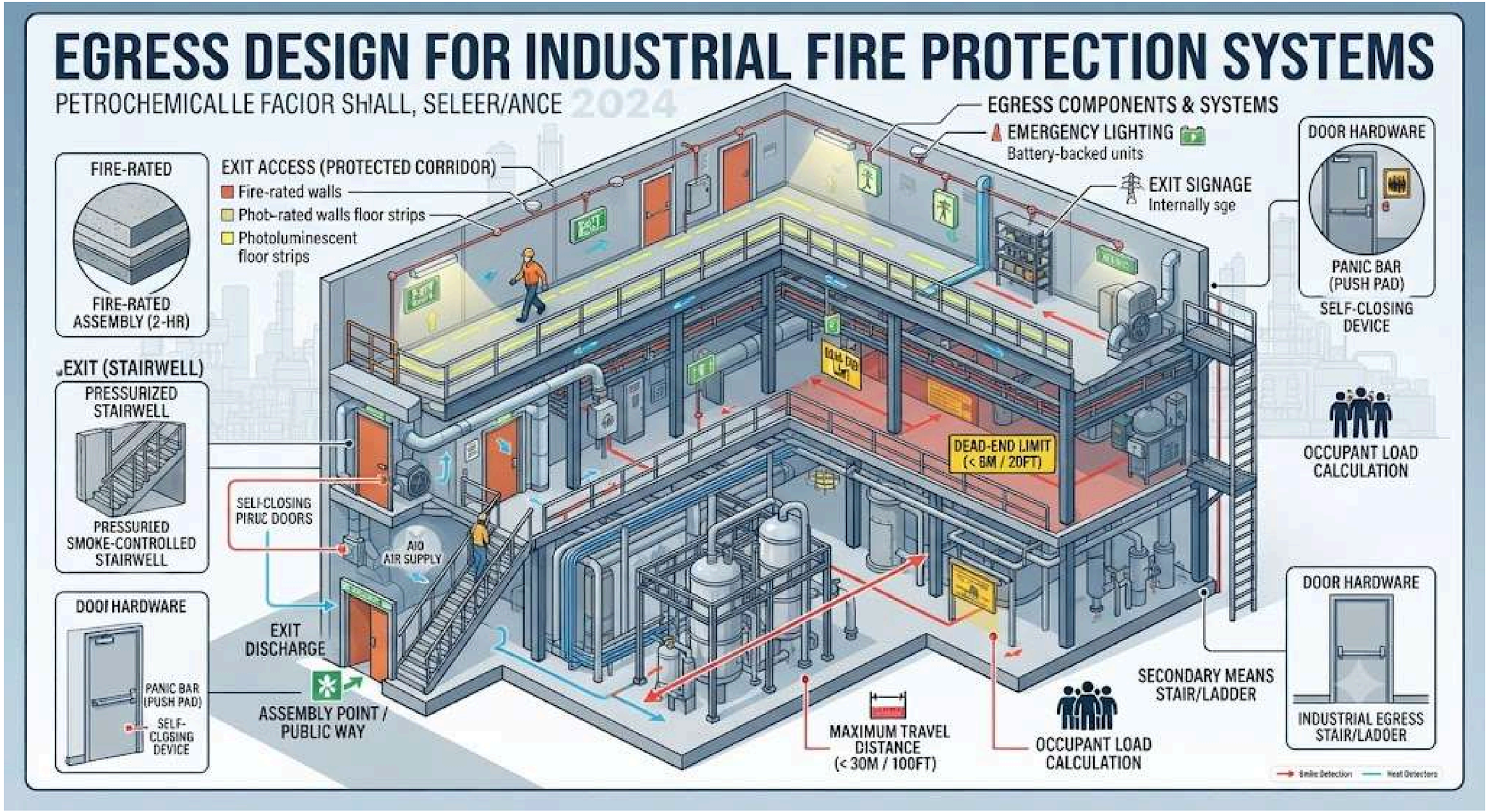
**Containment Boundary Stability:** Guaranteeing that load-bearing fire walls and compartment dividers maintain their structural rigidity under heat and thermal shock to block fire and smoke propagation.

**Facilitating Post-Fire Recovery:** Preserving the core framework of the facility to prevent total structural write-off, ensuring safer post-incident access for response teams and faster industrial rehabilitation.

# Concept of Egress Design

- **Three Components of Egress:** Comprises the **exit access** (leading to an exit), the **exit** (protected path like fire-rated stairwells), and the **exit discharge** (leading directly outside to a safe public way).
- **Occupant Load and Capacity:** Sizing corridors, doors, and stairwells based on the maximum number of workers per shift to prevent bottlenecks during rapid evacuation.
- **Travel Distance and Dead-End Limits:** Strict code-enforced limits on the maximum distance workers must travel to reach an exit, and restrictions on dead-end corridors where occupants could become trapped.

# Concept of Egress Design



# Concept of Egress Design

**Direction of Travel and Door Hardware:** Doors must swing outward in the direction of egress and be equipped with panic hardware (push bars) that can be operated easily without specialized knowledge or keys.

**Separation from High-Hazard Areas:** Routing escape paths away from heavy machinery, high-voltage electrical rooms, and flammable chemical storage zones.

**Emergency Lighting and Photoluminescent Signage:** Independent battery-backed emergency illumination and illuminated exit signs ensuring pathways remain visible during total facility power failure.

# egress design ,exit ,width calculations

- **Occupant Load Determination**: Calculated by dividing the net or gross floor area of the industrial space by the specific occupant load factor (square meters or feet per person), which varies depending on whether the area is used for low-hazard storage, standard manufacturing, or high-hazard processing.
- **Capacity Factors (Sizing Constants)**: Building codes (such as NFPA 101 or IBC) use specific multipliers based on the total occupant load—typically requiring a width factor of $0.3\ \text{inches per person}$ for stairways and $0.2\ \text{inches per person}$ for level components and ramps.
- **Minimum Clear Widths**: Establishes absolute code minimums regardless of calculation results, such as individual exit doors requiring a minimum clear width of 32 to 36 inches, and industrial corridors typically needing at least 44 to 60 inches to account for worker movement and equipment clearance.

# egress design ,exit ,width calculations

## EGRESS WIDTH CALCULATIONS FOR INDUSTRIAL FIRE PROTECTION SYSTEMS

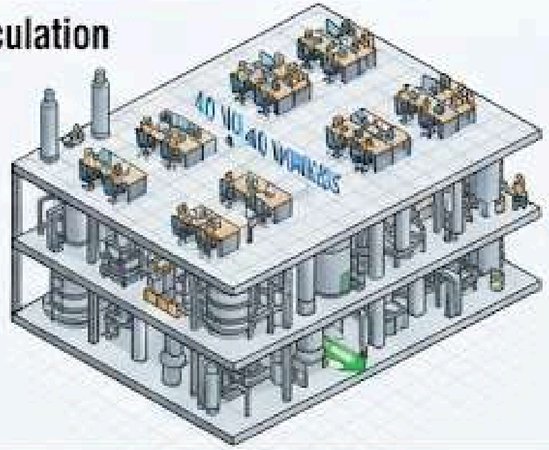
### DETERMINING REQUIRED EGRESS WIDTHS

#### 1 Occupant Load Calculation

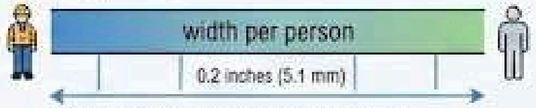
$$\text{OCCUPANT LOAD (OL)} = \frac{\text{AREA}}{\text{OCCUPANT LOAD FACTOR}}$$

PROCESS AREA:
1 person / 100 sq ft

STORAGE AREA:
1 person / 300 sq ft



#### 2 Capacity Factors




CORRIDOR/LEVEL COMPONENT:
0.2 inches (5.1 mm) per person

STAIRWAY COMPONENT:
0.3 inches (7.6 mm) per person

#### 3 Total Required Width

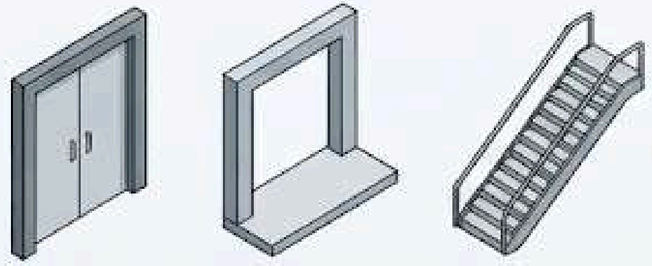
Total OL on Level 2 = 150 people

**REQUIRED WIDTH = OL × CAPACITY FACTOR**

| | | |
|---|---|---|
| LEVEL 2 CORRIDOR: 150 × 0.2 | = | 30 inches MINIMUM |
| LEVEL 2 STAIRWAY: 150 × 0.3" | = | 45 inches (1143 mm) MINIMUM |

### INDUSTRIAL EGRESS DESIGN PRINCIPLES & CONSTRAINTS

#### 1 Minimum Clear Widths

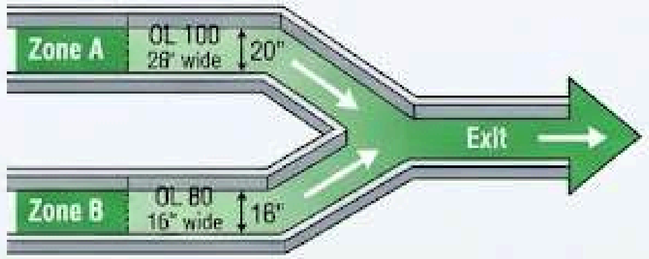


DOORWAY:
32" (813 mm) MIN.

CORRIDOR:
44" (1118 mm) MIN.

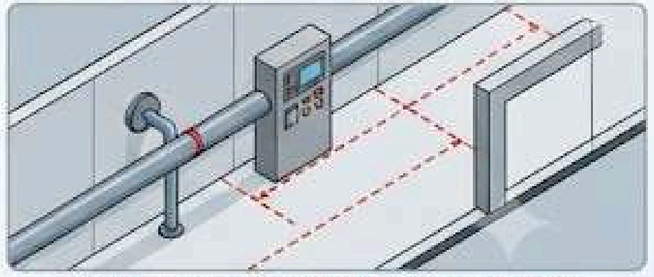
STAIRWAY:
44" (1118 mm) MIN.

#### 2 Cumulative Width Rule




20" + 16" = 36" (914 mm) MINIMUM

#### 3 Accounting for Obstructions



PERMANENT INDUSTRIAL EQUIPMENT MUST NOT ENCROACH ON CALCULATED WIDTH.

# egress design ,exit ,width calculations

- **Stairs vs. Horizontal Exits**: Accounts for slower vertical evacuation rates by applying larger width factors to stairwells compared to horizontal corridors, ensuring stair capacities match the discharge rates of incoming floors.
- **Cumulative Width Rule (No Bottlenecks)**: Mandates that the total width of an egress path can never decrease along the direction of travel; downstream exits and stairwells must be wide enough to handle the cumulative sum of all merging occupant loads from upstream zones.
- **Industrial Obstruction Accounting**: Factoring in physical footprints, machinery clearances, and material handling pathways so that permanent industrial layouts never encroach upon or narrow the calculated code-mandated clear exit widths.

# egress design ,exit ,width calculations

## Sample Calculation: Industrial Egress Width Design

This sample calculation demonstrates how to determine the required clear width for an industrial processing floor's egress components (corridors and stairwells) based on standard life safety engineering principles.

### 1. Given Design Parameters

- **Industrial Floor Area ($A$):** $10,000$ sq ft ($929$ m$^2$)
- **Occupant Load Factor (OLF):** $100$ sq ft per person (standard industrial manufacturing area)
- **Capacity Factors:**
  - Level components and corridors: $0.2$ inches per person ($5.1$ mm/person)
  - Stairways: $0.3$ inches per person ($7.6$ mm/person)

# egress design ,exit ,width calculations

2. Step-by-Step Calculation

- Step 1: Determine the Occupant Load ($OL$)

$$\text{Occupant Load} = \frac{\text{Area}}{\text{Occupant Load Factor}} = \frac{10,000 \text{ sq ft}}{100 \text{ sq ft/person}} = 100 \text{ occupant}$$

- Step 2: Calculate Required Level Component (Corridor) Width

$$\text{Width} = \text{Occupant Load} \times \text{Capacity Factor}$$

$$\text{Width} = 100 \text{ occupants} \times 0.2 \text{ inches/person} = 20 \text{ inches}$$

- Step 3: Calculate Required Stairway Width

$$\text{Width} = 100 \text{ occupants} \times 0.3 \text{ inches/person} = 30 \text{ inches}$$

# egress design ,exit ,width calculations

## 3. Code Minimum vs. Calculated Width Check

- **The Code Minimum Override:** Even though the mathematical calculations yield $20$ inches for corridors and $30$ inches for stairways, life safety standards (NFPA 101 / IBC) enforce strict absolute minimum clear widths:
  - Industrial corridors require a minimum clear width of $44$ inches ($1118$ mm).
  - Exit stairways serving 50 or more occupants must be at least $44$ inches wide.
- **Final Engineering Decision:** Because code minimums override smaller mathematical results to prevent bottlenecks, the designed width for both the corridor and stairway must be scaled up to $44$ inches.

# egress design ,exit ,width calculations

## Industrial Egress Design Sample Calculation

This complete, exam-ready calculation demonstrates how life safety engineers size exit components (corridors and stairways) for an industrial facility based on standard building codes (such as NFPA 101 and the International Building Code).

### 1. Design Scenario and Parameters

- **Industrial Zone Area ($A$):** $12,000$ sq ft ($1,115$ m$^2$)
- **Occupant Load Factor (OLF):** $100$ sq ft per person (standard industrial manufacturing classification)
- **Capacity Factors:**
  - Level components / corridors: $0.2$ inches per person ($5.1$ mm/person)
  - Exit stairways: $0.3$ inches per person ($7.6$ mm/person)

# egress design ,exit ,width calculations

## 2. Step-by-Step Sizing Procedure

- **Step 1: Calculate the Occupant Load ($OL$)**
  - Formula: $OL = \text{Area}/\text{OLF}$
  - Calculation: $12,000 \text{ sq ft}/100 \text{ sq ft/person} = 120 \text{ occupants}$
- **Step 2: Calculate Required Corridor Width**
  - Formula: $\text{Width} = OL \times \text{Capacity Factor}$
  - Calculation: $120 \text{ occupants} \times 0.2 \text{ inches/person} = 24 \text{ inches}$
- **Step 3: Calculate Required Stairway Width**
  - Formula: $\text{Width} = OL \times \text{Capacity Factor}$
  - Calculation: $120 \text{ occupants} \times 0.3 \text{ inches/person} = 36 \text{ inches}$

# egress design ,exit ,width calculations

## 3. Code Minimum Override & Final Decision

- **The Rule:** Mathematical calculations provide a baseline, but life safety codes enforce strict absolute minimums to prevent physical bottlenecks during an emergency.
- **Corridor Minimum:** While the calculation yields $24$ inches, industrial codes mandate a minimum clear corridor width of $44$ inches.
- **Stairway Minimum:** While the calculation yields $36$ inches, exit stairways serving more than 50 occupants must have a minimum clear width of $44$ inches.
- **Final Sizing:** Because code minimums override smaller mathematical results, the final designed width for both the exit corridor and stairwell must be $44$ inches.

# Fire Certificates

- **Legal & Statutory Mandates**: Official documentation (such as a Fire No Objection Certificate or Fire Safety License) issued by local fire and rescue authorities confirming that an industrial facility complies with structural, active, and passive safety regulations.
- **Prerequisite for Occupancy & Licensing**: Acts as a mandatory legal prerequisite before a factory or industrial plant can obtain its official building occupancy certificate, industrial licenses, and factory operational clearance.
- **Alignment with Approved Design Layouts**: Requires precise execution and verification of engineered plans—including fire pump capacities, hydrant positioning, sprinkler zones, and evacuation width calculations—matching official submissions.
- **Mandatory Testing & Maintenance Logs**: Tied directly to ongoing compliance frameworks (such as NFPA standards or local codes), requiring documented periodic tests of fire pumps, water flow rates, alarms, and extinguishers.
- **Periodic Renewals & Audits**: Subject to mandatory scheduled renewals (typically annually or biennially for industrial facilities) backed by third-party or state-administered fire safety inspections and operational audits.

# Fire Certificates

GLOBAL INDUSTRIAL
SAFETY STANDARDS INSTITUTE

NATIONAL FIRE SAFETY &
COMPLIANCE AUTHORITY

## CERTIFICATE OF INDUSTRIAL FIRE PROTECTION SYSTEM COMPLIANCE

This is to certify that the Industrial Fire Protection Systems installed at the facility described below have been inspected, tested, and verified to meet all required safety codes, standards, and regulations.

| | | | |
|---|---|---|---|
| **FACILITY NAME:** | ORION PETROCHEMICALS - COMPLEX B | | |
| **LOCATION:** | 7401 INDUSTRIAL RD, PORT ARTHUR, TX 77642 | | |
| **CERTIFICATE NO:** | OFC-TX-740-9912-B | **ISSUE DATE:** | OCTOBER 12, 2024 |
| **EXPIRATION DATE:** | OCTOBER 12, 2024 | **EXPIRATION DATE:** | OCTOBER 12, 2026 |
| **CERTIFIED SYSTEMS:** | 1. Automatic Sprinkler System (NFPA 13)<br>2. Fire Pump & Hydrant System (NFPA 20/24)<br>3. Deluge Foam System (NFPA 16)<br>4. Fire Alarm & Detection System (NFPA 72)<br>5. Structural Fireproofing (ASTM E119) | | |

The systems are confirmed to be in full operational readiness and aligned with the approved fire hazard analysis and design drawings. All maintenance and testing logs up to the issue date have been audited and approved.

Chief Fire Inspector

CHIEF FIRE INSPECTOR,
STATE FIRE MARSHAL'S OFFICE

STATE OF FIRE MARSHAL

AUTHORITY HAVING JURISDICTION
(AHJ) REPRESENTATIVE

# Fire Certificates

Here are the important points regarding **Indian Norms and Standards** for Industrial Fire Protection Systems:

- **National Building Code of India (NBC)**: Published by the Bureau of Indian Standards (BIS), **NBC Part 4 (Fire and Life Safety)** serves as the core legal and regulatory framework governing building classification, fire loads, compartmentation, and life safety in India.
- **Statutory Enforcement**: While the NBC is fundamentally a model code, it acquires binding legal status once incorporated into state-level **Factory Rules, Municipal Building Bye-Laws, and State Fire Service Acts**.
- **Key Indian Standards (IS Codes)**: Specific engineering practices and equipment installations are regulated through dedicated BIS codes, including:
  - **IS 15105**: Design and installation of automatic sprinkler fire suppression systems.
  - **IS 3844**: Code of practice for fire hydrant and external water supply systems.
  - **IS 2189**: Selection, installation, and maintenance of automatic fire detection and alarm systems.
  - **IS 13848**: General fire safety requirements specifically tailored for industrial buildings and manufacturing facilities.

# Fire Certificates

**Mandatory Egress Parameters under Indian Norms**: Dictates strict dimensional baselines for industrial escape routes, such as a **minimum staircase width of 1,500 mm** for industrial buildings and strict caps on maximum travel distances based on hazard classifications.

**Fire NOC & Statutory Compliance**: Industrial plants must secure and annually renew a **Fire No Objection Certificate (Fire NOC)** issued by the local State Fire and Rescue Services Department, verifying that active and passive systems comply with approved NBC design layouts.

# Fire Certificates

DIRECTORATE OF FIRE SERVICES
अग्निशमन सेवा निदेशालय

GOVERNMENT OF INDIA
भारत सरकार
MINISTRY OF HOME AFFAIRS
गृह मंत्रालय

STATE FIRE & RESCUE SERVICES (e.g., Maharashtra)
राज्य अग्निशमन एवं बचाव सेवा

## FIRE SAFETY NO OBJECTION CERTIFICATE (NOC)

This is to certify that the Industrial Fire Protection Systems installed at the facility described below have been inspected, tested, and verified to meet all required Indian National Building Code (NBC) Part 4 standards and local fire safety regulations. The facility is hereby granted No Objection Certificate for operation.

| | | | |
|---|---|---|---|
| **CERTIFICATE NO:** | MH-FSD-NOC-IND-2024-7741 | **DATE OF ISSUE:** | OCTOBER 15, 2024 |
| **DATE OF ISSUE:** | OCTOBER 15, 2024 | **DATE OF EXPIRY:** | OCTOBER 14, 2026 |
| **FACILITY NAME:** | **BHARAT PETROCHEMICALS - MUMBAI REFINERY** | | |
| **LOCATION:** | MAHUL ROAD, CHEMBUR, MUMBAI, MAHARASHTRA 400074 | | |
| **OCCUPANCY TYPE:** | **INDUSTRIAL (HAZARDOUS - GROUP G)** | | |
| **CERTIFIED SYSTEMS:** | 1. Automatic Sprinkler System (IS 15105)<br>2. Fire Hydrant & External Water Supply (IS 3844)<br>3. Foam Deluge System (IS 16) - High Risk Areas<br>4. Fire Detection & Alarm System (IS 2189)<br>5. Structural Fire Protection - Class A | | |

This NOC is issued subject to continued maintenance of all systems in operational readiness and annual third-party verification. Any unauthorized modification to the facility or systems will render this certificate void.

CHIEF FIRE OFFICER
मुख्य अग्निशमन अधिकारी

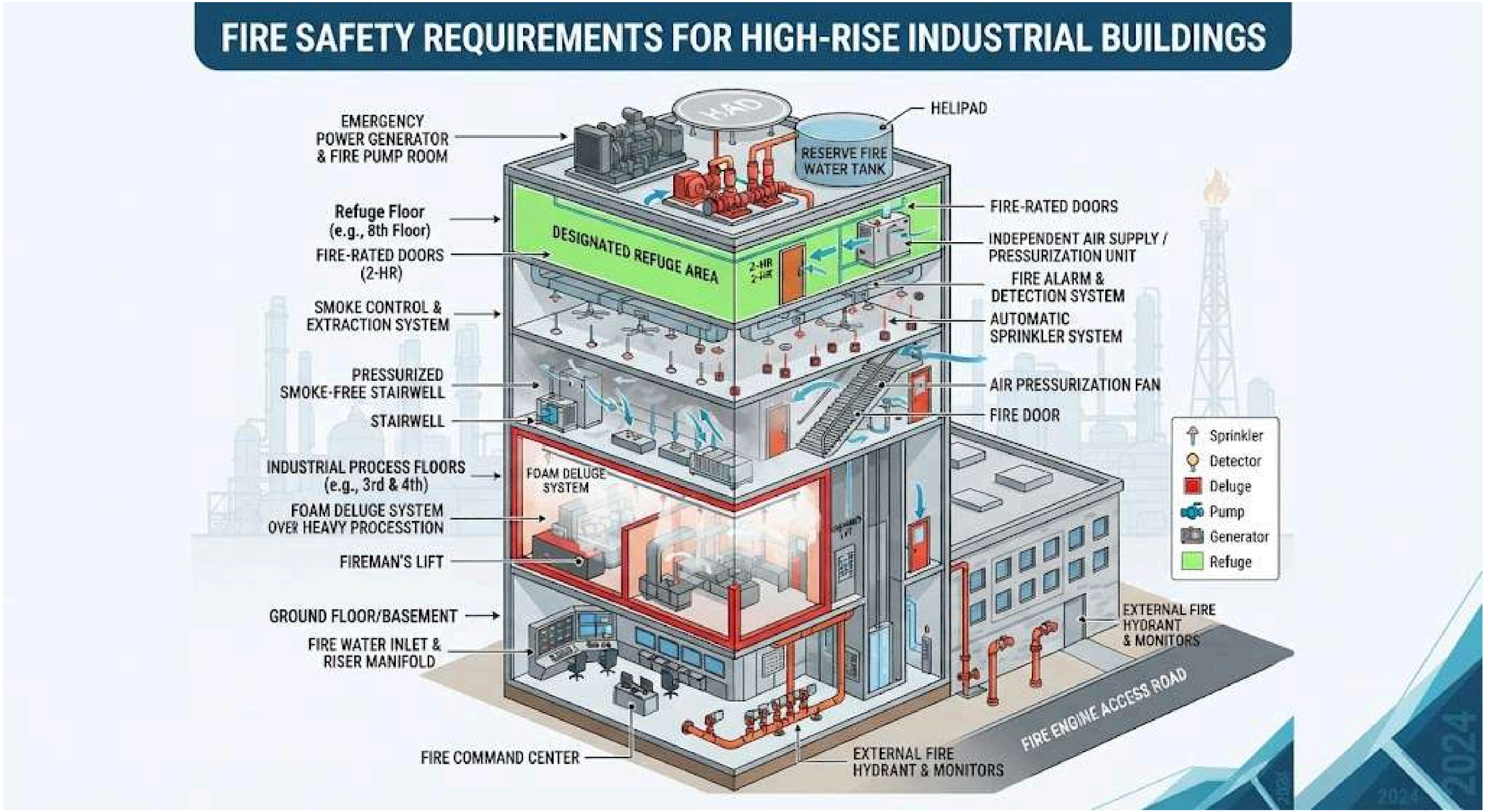
AUTHORITY HAVING JURISDICTION (AHJ)
प्राधिकारी

DIRECTORATE OF FIRE SERVICES
GOVT. OF INDIA

# Fire Safety Requirements for High Rise Buildings

- **Height and Classification Thresholds:** Typically triggered when building heights exceed **15 meters or more** (as defined by the National Building Code of India Part 4), imposing stringent engineering requirements beyond low-rise industrial structures.
- **Fire-Rated Compartmentation & Refuge Areas:** Mandates the division of high-rise structures into vertical fire compartments and the inclusion of dedicated **refuge floors** equipped with independent fire-rated ventilation to temporarily shelter occupants during a multi-floor evacuation.
- **Pressurized Stairwells & Smoke Management:** Requires mechanical pressurization systems in exit stairwells to prevent toxic smoke infiltration during a fire, alongside automated smoke extraction systems in large atriums and corridors.

# Fire Safety Requirements for High Rise Buildings



# Fire Safety Requirements for High Rise Buildings

- **Dedicated High-Rise Fire Water Infrastructure:** Demands multi-stage fire pumps, terrace booster pumps, and dedicated wet risers/downcomers capable of delivering adequate pressure and flow rates to upper stories where municipal fire engines cannot reach directly.
- **Emergency Power & Life Safety Backups:** Mandates automatic emergency generators to ensure uninterrupted power supply for fire pumps, emergency lifts (fireman's lifts), pressurization fans, and emergency egress lighting during complete grid failure.

# snookers.

Here are the important points regarding **Pipe Snubbers** (hydraulic or mechanical shock arrestors) relevant to building fire safety in industrial fire protection systems:

- **Dynamic Restraint During Emergencies**: Designed to allow slow, normal thermal expansion and contraction of fire water mains, but instantly lock rigid during sudden high-impact events like seismic activity or industrial explosions.
- **Water Hammer and Surge Control**: Absorbs severe hydraulic shock waves and pressure spikes caused by rapid pump startups or quick-closing deluge valves, protecting pipe welds, fittings, and joints from cracking.
- **Prevention of Pipe Dislodgement**: Secures heavy, suspended overhead fire suppression piping and large-diameter headers, preventing them from breaking loose and collapsing onto personnel or equipment during an emergency.
- **Maintenance of System Integrity**: Ensures that the entire active fire water distribution network remains physically aligned, pressurized, and fully functional right when suppression operations begin.
- **Resilience in High-Hazard Facilities**: Critical in heavy industries (such as oil refineries and chemical plants) where structural vibrations and potential blast overpressures could otherwise shear rigid fire protection piping.

snookers.


PIPE SNUBBERS IN INDUSTRIAL FIRE PROTECTION SYSTEMS: BUILDING FIRE SAFETY
DYNAMIC RESTRAINT AGAINST SEISMIC EVENTS & HYDRAULIC SHOCK
HYDRAULIC PIPE SNUBBER (SEISMIC/SHOCK ARRESTOR)
ALLOWS SLOW THERMAL MOVEMENT
INSTANTLY LOCKS RIGID DURING SHOCK/
INSTANTLY SUDDEN SEISMIC EVENT
DELUGE VALVE STATION
FIRE DETECTION SENSORS
FIRE ALARM CONTRO EPANEL PANEL
FIRE WATER DELUGE HEADER
MECHANICAL PIPE SNUBBER
ACCOMMODATES PIPE GROWTH
LOCKS ON SUDDEN ACCELERATION
CONTROLS VIBRATION & WATER HAMMER HAMMER
DELUGE VALVE VIVE STATION
PIPE SUPPORT WITH SNUBBER
RIGID SUPPORT POINT
SNUBBER RESTRAINT
SEISMIC SHAKE
EMERGENCY PUMP START/QUICK VALVE CLOSURE
DELUGE SPRINKLER NOZZLES NOZZLES
CABLE TRAY
FIRE ALARM CONTROL PANEL
IMPACT FORCE ABSORBED BY
SEISMIC SHAKE
NORMAL THERMAL EXPANSION PERMITTED