Fire Detection and Protection for Cement and Power Plants

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INTRODUCTION

HOLTEC

Today's presentation is exclusively for fire detection and protection for the industry and power plant. The presentation covers hazard categories, fire detection system and different types of protection system such as Hydrant system, spray system, sprinkler system etc.

CONTENT

01	Necessity of Fire Detection and Protection System
02	Classification of Fire
03	Hazard Classification and applicable hazard category for Cement and Power Plant
04	Fire Detection and Alarm System
05	Fire Protection System
06	Applicable Codes and Standards
07	Typical Fire Detection and Protection system Diagram
08	Important Points to be Considered
09	Holtec Experience

NECESSITY OF FIRE DETECTION & PROTECTION

- Life and Equipment Safety.
- Statutory Requirement and Factories Act.
- Property Protection and loss prevention.



CLASSIFICATION OF FIRE

- **Fire is due to fuel, Heat and Oxygen known as Fire triangle.**

  Fuel – combustible material
  Heat – ignition source
  Oxygen – supports combustion

  Removing any one element extinguishes the fire.

- **Class A fire – Due to wood, paper, rubber.**
- **Class B fire – Flammable liquids.**
- **Class C fire – Flammable gases and due to electrical.**
- **Class D fire – Metal.**
- **Class K/F fire – Cooking oils.**

HAZARD CLASSIFICATION AND APPLICABLE HAZARD CATEGORY FOR CEMENT AND POWER PLANT



- **Hazard classification as per Tariff Advisory Committee (TAC):**

  Light Hazard ---------- CEMENT PLANT
  Ordinary Hazard ----------POWER PLANT
  High Hazard (A)
  High Hazard (B)

For cement plant, it is light hazard and for power plant, it is ordinary hazard. When considered Fire fighting system is used for both cement and power plant, design specified is ordinary hazard.

- **Hazard classification as per IS 15105: Automatic sprinkler system**

  Light Hazard----------CEMENT PLANT
  Ordinary or moderate Hazard-------POWER PLANT
  High Hazard
  Storage Hazard

Cement and power plant factories are grouped under ordinary or moderate hazard and accordingly, sprinkler system to be designed.

- **Hazard classification is also given in National Building Code of India Part 4 - Fire and Life safety and IS 1641**
- **Specifically for power plant and Distribution station, IS 3034, NFPA 850 can be referred.**

Cement Plant Hazards : Light Hazards

Location	Cause of fire	Risk Type
Coal Mills	*Spontaneous combustion, dust explosion, friction ignition.*	*Critical*
Kiln and Pyro processing		
Kiln Burner system	*Back firing, CO accumulation, refractory failure*	*High*
Preheater Tower	*Back firing, CO accumulation, refractory failure*	*High*
Calciner Unit	*Back firing, CO accumulation, refractory failure*	*High*
Alternate Fuel Injection	*Back firing, CO accumulation, refractory failure*	*High*

Location	Cause of fire	Risk Type
Conveyors	*Belt friction and hot bearings. Fire during maintenance.*	*Critical*
Bag filter	*spontaneous combustion, dust explosion, friction ignition.*	*Critical*
Cable galleries	*Electrical fire.*	*High*
Control room, MCC room	*Electrical fire.*	*High*
Coal storage	*Oxidation and self ignition*	*Critical*
Silo and Bunker	*spontaneous combustion, dust explosion, friction ignition.*	*Critical*
ESP	*CO accumulation leading to explosion*	*High*
Electrical system failure in unmanned substation	*Electrical fire.*	*High*

Power Plant Hazards: Ordinary Hazard

Location	Cause of fire	Risk Type
Coal storage	*oxidation and self ignition.*	Critical
Cable galleries	*Electrical fire.*	High
Control room, MCC room	*Electrical fire.*	High
Conveyors	*Belt friction and hot bearings. Fire during maintenance.*	Critical
Turbine Lube oil system	*oil leaks.*	High
Hydrogen cooled generators	*flammable gas fire – escalate into violent explosion or flash fire*	Critical
Transformer	*Oil fire*	High
Oil storage	*Oil leak and vapour*	High

FIRE DETECTION & ALARM SYSTEM

- It is an automatic safety system designed to detect the presence of fire at its earliest stage, alert occupants, and initiate emergency actions to minimize the loses.
- Smoke detectors: early warning in clean areas. (ex: Control room, UPS room)
- Heat detectors: dusty/high-temperature / fumes possible areas. (ex. Battery room, Cable trays, Transformers etc.,)
- Gas detectors: H2 (Battery rooms)
- Manual Alarm Call Point (for the whole facility)

Types of Fire Detection:

- Addressable (exact detector with location can be identified)
- Conventional (only particular zone will be identified)

FIRE PROTECTION SYSTEM



<u>Fire protection</u> is the prevention and reduction of the hazards associated with fires. Fire protection has two major goals:

- Life Safety
- Property Protection

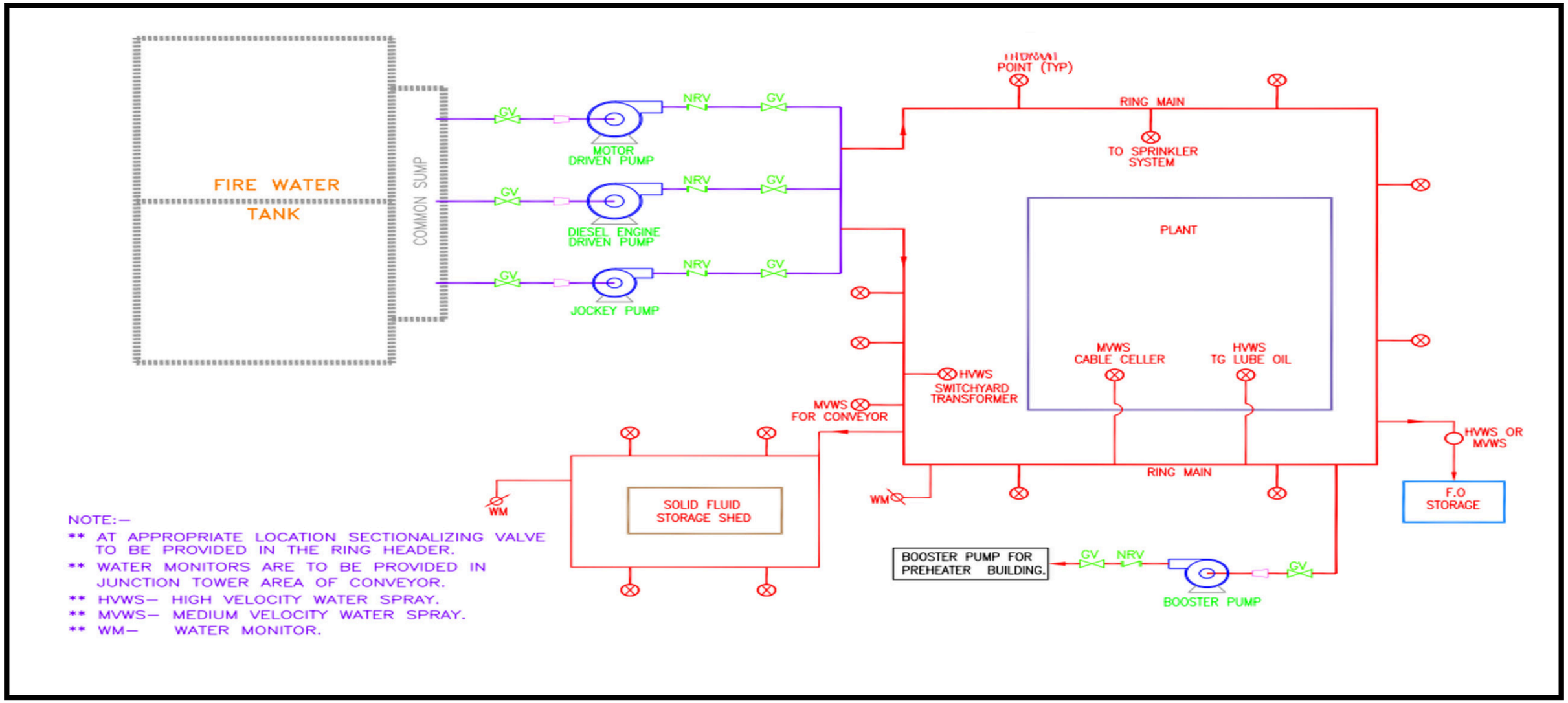
Types of Fire Protection System:

- Active Fire Protection (Ex: Hydrant System, Spray System etc.,)
- Passive Fire Protection (Ex: Fireproof paintings / coatings, Fireproof Doors, Fire Dampers etc.,)

Active Fire Protection System:

- Water Based systems (Hydrants, Deluge etc.,)
- Gas Based systems (CO_2 system, FM200 system etc.,)
- Portable Fire Extinguishers.

Water-Based Active Fire Protection System



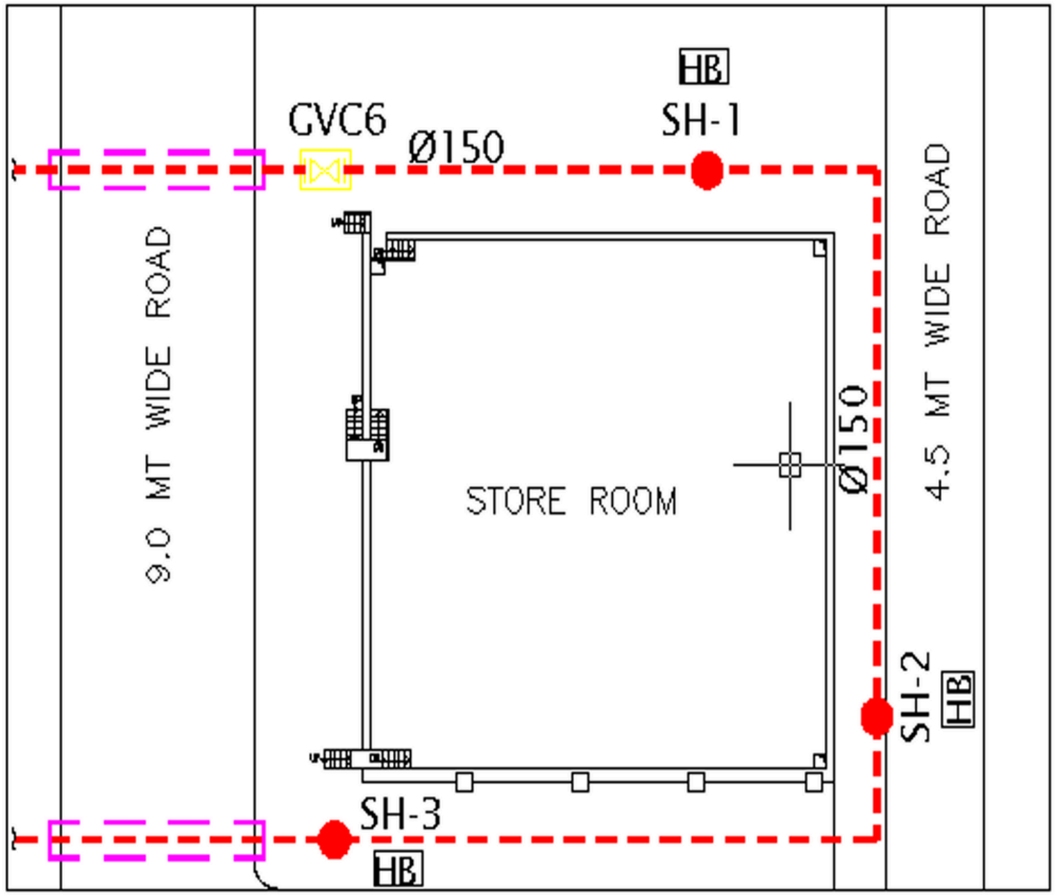
Hydrant System

- Hydrant systems provide manual firefighting water around the plant.
- Spacing between Hydrants:

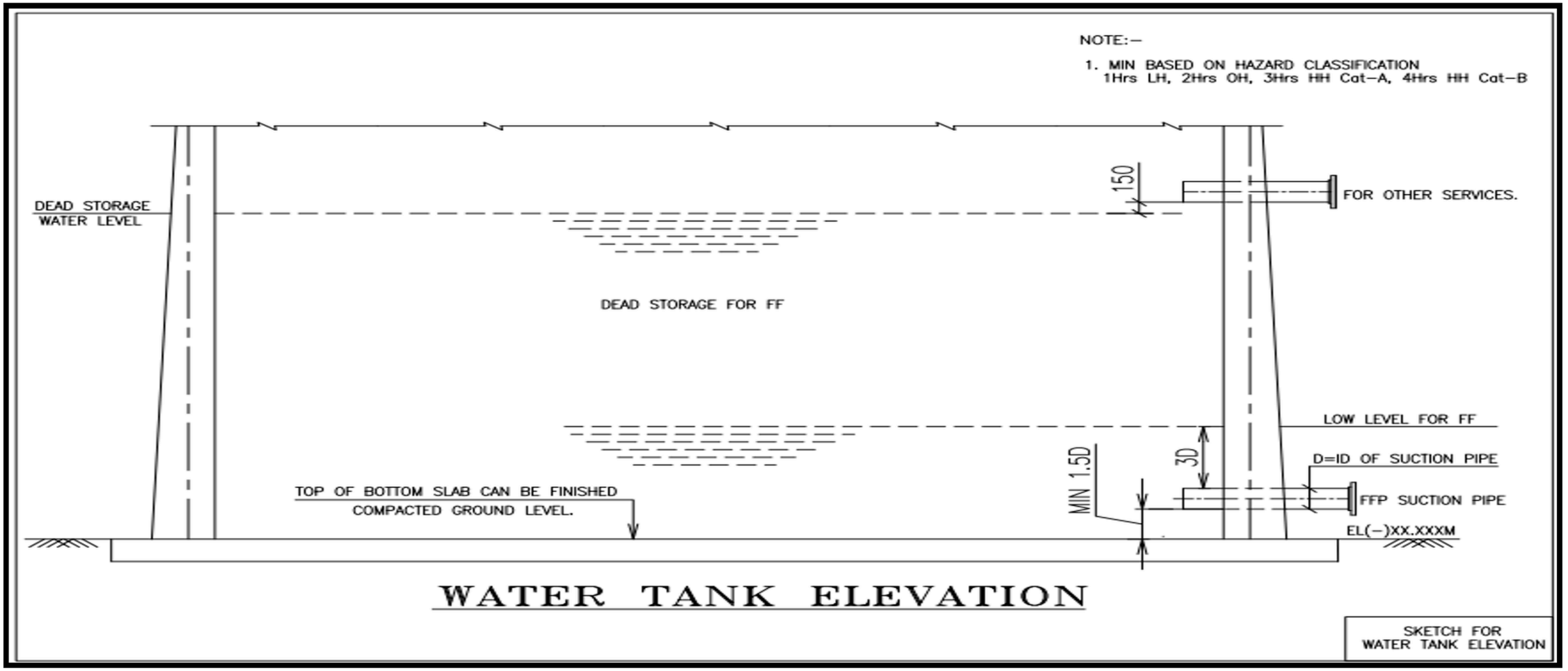
  Light Hazard - 60m

  Ordinary Hazard - 45m

The Design and Selection of number of Hydrants for combined Cement and Power plant is based on Ordinary Hazard.



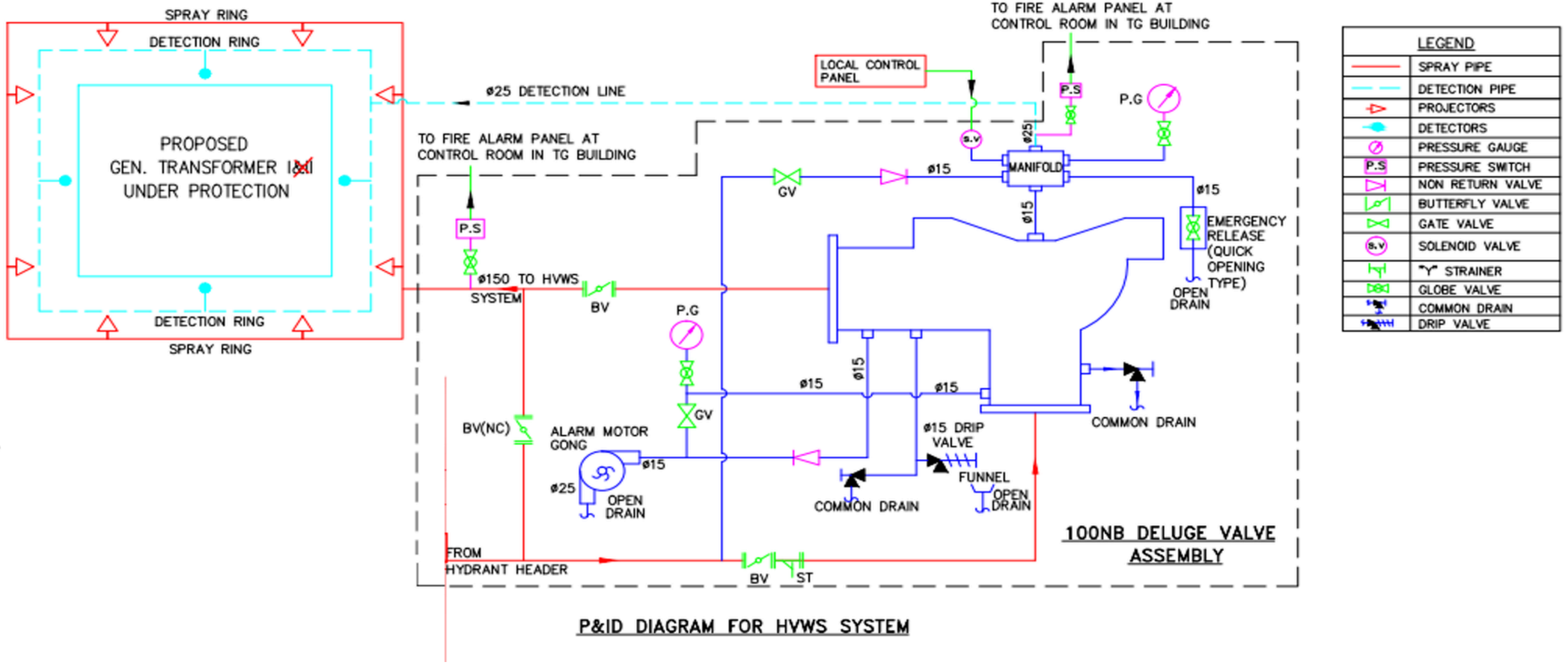
Typical Diagrams in Fire fighting system



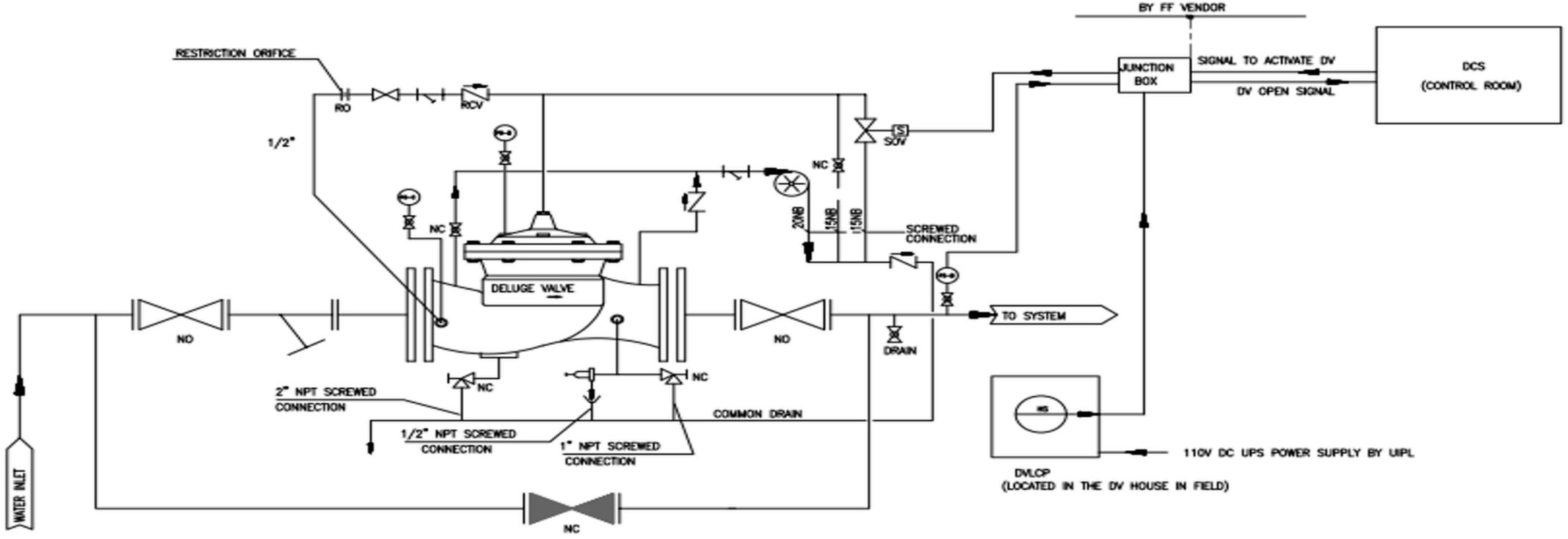
Automatic HVWS / MVWS or DELUGE SYSTEM

- Deluge systems discharge water simultaneously through open nozzles to protect transformers, cable trays and conveyors through automatic actuation through fire detection or manual actuation.
- For oiled filled Transformer, Nitrogen injection fire protection system (NIFPS) is used along with HVWS.
- NIFPS is used for internal tank explosion prevention & fire suppression. HVWS is used for external fire control and exposure cooling.
- For indoor, basement installation of transformer, NIFPS is preferred over HVWS.





P&ID DIAGRAM FOR HVWS SYSTEM



TYPICAL DETAILS OF AUTOMATIC DELUGE SYSTEM

Gas Based Fire Protection Systems

- Gas based systems, in which Gas is used as Extinguishing Media, which reduces the percentage of oxygen concentration in the surrounding atmosphere lower than the percentage required for combustion.
- Works on the principle of “Reducing Oxygen Content”.

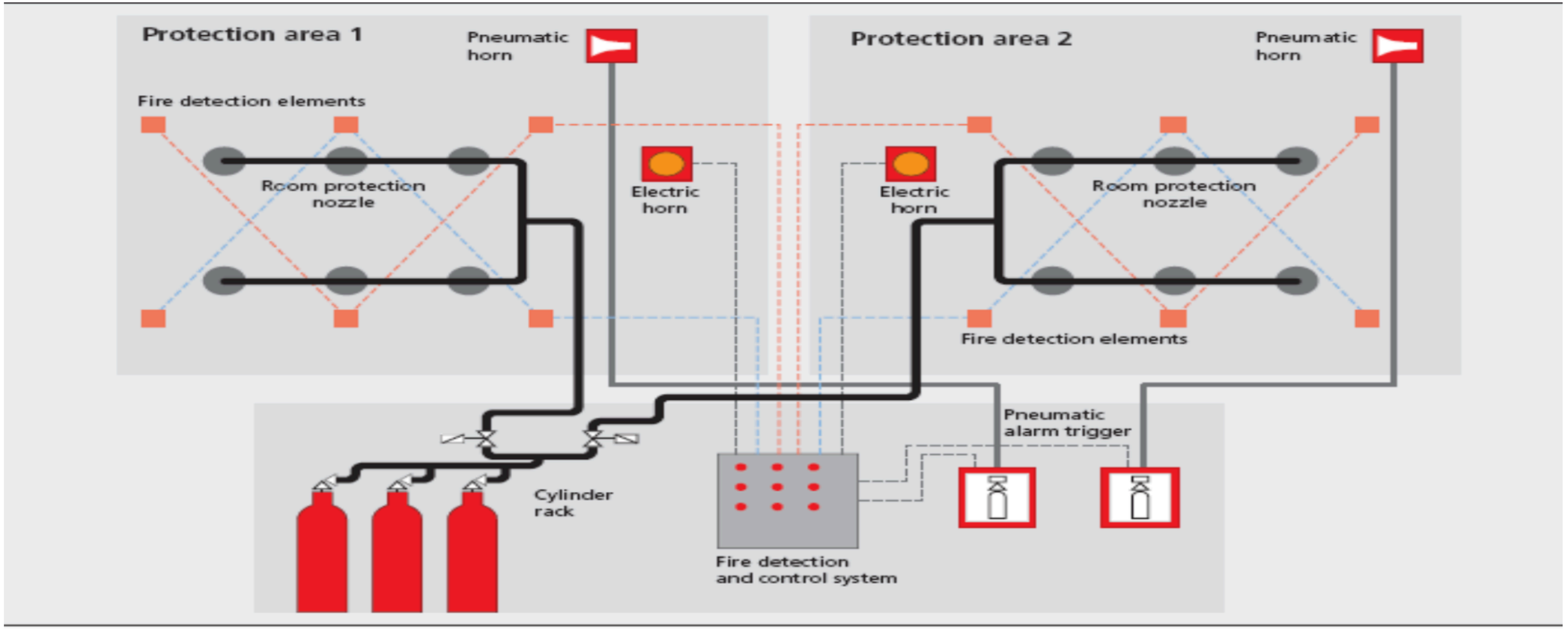
Types of Gas Based System

- CO_2 Flooding System for Turbine generators
- Inert Gas (ex: Inergen) / Chemical Gases (ex: FM 200) for Control rooms

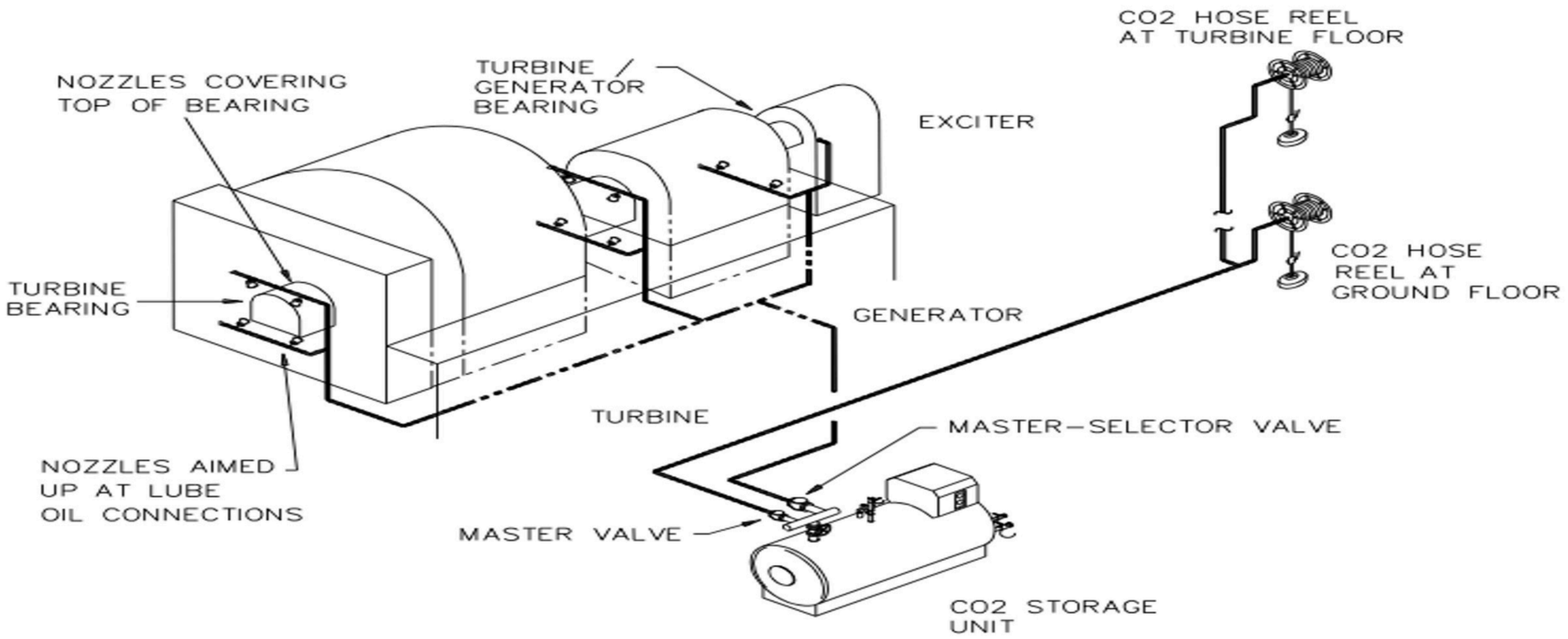
FM 200 Fire Supression System



Gas Extinguishing System Schematic DIagram



Low Pressure CO_2 Turbine Bearing Protection



PORTABLE FIRE EXTINGUISHRERS



Wood, Paper, Plastic, Cloth



Flammable Liquids, Grease, Gas



Electrical



Combustible Metals

Extinguisher	Class A	Class B	Class C	Class D
Water Extinguisher	Yes	No	No	No
CO2 Extinguisher	No	Yes	Yes	Yes
ABC Extinguisher	Yes	Yes	Yes	Yes
K Extinguisher	Yes	Yes	No	No
Foam based Extinguisher	Yes	Yes(for liquids)	No	No

TYPE OF FIRE FIGHTING SYSTEM FOR VARIOUS LOCATIONS

Type of System	Location
Standpipe and hose system	Boiler, Dust collector, TG Building, Junction tower and entire cement plant at suitable locations
Yard mains and hydrant	Switch yard, Transformer area, coal yard and all around cement and power plant
Fire alarm and signaling	All electrical/Instrumentation panel rooms
Manual call point and electric horn	Outdoor area
Portable fire extinguishers	Portable fire extinguishers shall be provided at strategic locations of entire plant
Water spray fixed system (HVWS & MVWS)	Outdoor transformer in switch yard, Turbine lube oil system, conveyor, cable cellar, oil storage

APPLICABLE STANDARDS

Standard for various Fire Fighting System:

- TAC
- Indian Standard
- NFPA
- National Building Code
- OISD Standard
- FM Standard
- UL Standard

SALIENT POINTS FOR CONSIDERATION



Fire Water Tank

- When water demand is 225m^3 and above, 02 compartments to provided. Each compartment capacity shall be % of total water demand.
- Total capacity based on Hazard classification and pump capacity in m^3/hr.
  - *1 hour for light hazard*
  - *2 hour for ordinary hazard*
  - *3 hour for high hazard cat A*
  - *4 hour for high hazard cat B*
- Storage volume for Fire Fighting is the volume between 150mm below bottom of other service nozzle and low level. Low level is minimum 3xID of fire fighting pump suction pipe.
- Tanks can be from RCC, steel.
- Typically for Fire Fighting system with 100 Hydrants, the Fire water tank capacity is 546 cum. Two hour storage shall be there considering Ordinary Hazard.
- The tank shall be in two compartments with each of capacity 273 m^3.

Fire Water Pump

- Capacity shall be for the highest water demand calculated based on hydrant system, spray system and sprinkler system.
- Water demand based on hydrant system with supplementary hose demand or spray system water demand or sprinkler system water demand, whichever is higher.
- Pumps capacity are selected based on highest water demand and types of hazard. If number of hydrants exceed 100, one more pump to be added for every 125 hydrants.
- The head of pump shall be 7 bar (g)/8.8 bar (g).
- The head selection shall also be checked to get minimum 3.5 bar (g) pressure at the farthermost hydrant.
- If high velocity and medium velocity spray system are also provided, the hydrant system water demand to be increased by supplementary hose demand for finalization of pump capacity.
- Booster pump for very high location in the plant especially the PH tower of the cement plant.
- Supplementary hose demand values:
  For MVWS – 4500 lpm.
  For HVWS – 1750 lpm.
- Typically for Hydrant system with 100 hydrants, the Fire water pump capacity shall be 273 cum/h for motor driven and diesel engine driven pump. If the number of hydrants exceeds 100 nos., it shall be 03 pumps with capacity 273 cum/hr each. Out of 03 pumps, 02 will be electric driven and 01 will be diesel driven.

Spray Water Density

System	Type of Spray	Density (lpm/m^2)
Oil filled Transformer	HVWS	10.2
Conveyor Belts	MVWS	10.2
Turbine lube oil	MVWS	20.4
Cable Cellar	MVWS	12.2
Sprinkler system		
Light Hazard	-	2.5
Medium Hazard	-	5
High Hazard	-	7.5-10

- The selected pump characteristic shall be to set 150% of rated flow at 65% of rated head.
- Pump shut-off head shall not exceed 120% of rated head for horizontal pump and 140% of rated head for vertical pump.

Jockey Pump

- Capacity – 3% to 5% of pumping capacity subject to minimum flow of 10.8 m^3/hr.

Piping

- Cast Iron pipe.
- Centrifugally cast iron pipe.
- Centrifugally cast ductile iron pipe.
- Carbon Steel pipe IS 1239 Part I medium up to NB 150 size.
- Carbon Steel pipe as per IS 3589 for pipe size above NB 150.
- CPVC, UPVC, HDPE pipes are permitted only if it is under ground and only for light hazard.

Note: We may have to provide pressure relief valve at suitable locations to avoid pressure build up in the over ground piping system due to water expansion caused by the extreme atmospheric temperature. The approximate pressure increase in a piping system of size NB100 to NB250 will be around 3 bar(g) / degree c which can cause failure of flange joints.
For under ground fire water mains, we can use either Carbon steel pipes with required thickness of coating and wrapping or ductile iron pipe.

It is preferable to go for over ground hydrant main than under ground hydrant main as under ground hydrant main is prone for failure to failure of wrapping material and leading to corrosion of pipe.
The maintenance of under ground pipe is also very difficult.

In case of under ground Hydrant mains

- Coating and wrapping of under ground Carbon Steel pipeline are required.
- Use only coal tar based anti-corrosion tape.
- Bitumen based tapes shall not be used. Bitumen based tapes are prohibited as SRB (Sulphate Reducing Bacteria) attacks the bitumen based tapes and destroy the tapes.
- Thickness of coating and wrapping material is based on the corrosivity of soil.
- Lower the soil resistivity, higher the corrosive nature.

Soil Resistivity (ohm-cm)	Corrosive nature of soil	Coats	Wraps	Minimum Thickness (mm)
1000	Extremely corrosive	3	3	7
1000-5000	corrosive	2	2	4
Above 5000	-	1	1	3

FIRE DETECTION AND PROTECTION SYSTEM EFFECTIVENESS – BENCHMARK

Requirements	Target
Inspection completion rate	98%
Hot work compliance	100%
Training	95%
Near miss reporting culture	10% and above
Fire Drill completion	100% on schedule
To be achieved	
Fire incidents/year	Zero
Average response time	Less than 04 min
Fire related downtime	Zero
Property damage cost	Zero
Authority findings on shortcomings	Zero

- **Some report says that every 03 days, there is fire incident in cement plant with coal handling and ESP accounting around 70%.**

HOLTEC EXPERIENCE

- Holtec has done many projects involving fire detection and protection system packages.
- Holtec is fully conversant with all the fire detection and protection system requirements for cement plant, power plant, conveyors, oil storages etc.
- Holtec is fully conversant with various Codes, specifications for fire fighting system such as TAC, NFPA, Building Code, Indian Standard, FM requirement, UL requirement.
- Holtec can design the optimum cost effective fire detection and protection system consisting of Hydrant system, spray system, sprinkler system, detection system, alarm system etc. meeting all Codes and Standards.
- Holtec is fully conversant with pumping system design, tank design and selection, piping system design including hydraulic calculations.
- Holtec can take up any fire fighting system consultancy either a part of the project or only fire fighting system addition to existing or new project.

CONCLUSION

The requirement of Fire fighting system is for saving the human and property loss. In addition, it is required as per statutory codes and insurance point of view. Therefore, it is recommended to provide minimum fire detection and protection system as specified in Codes and Standards.

THANK YOU



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