FIRE PROTECTION SYSTEM

PT. Fire Maintenance Indonesia
Fire Maintenance Specialist
What can we do?
Advice, support and recommendation of Fire Protection Systems to Client in order to comply with fire code, standard and regulation
INTERNATIONAL CODES AND STANDARDS

- NFPA 1 – Fire Code, 2009 Edition
- NFPA 10 – Portable Fire Extinguishers
- NFPA 11 – Low, Medium, and High Expansion Foam
- NFPA 13 – Installation of Sprinkler System
- NFPA 14 – Standard for the Installation of Standpipe and Hose System
- NFPA 20 - Standard for the installation of Stationary Pumps
- NFPA 22 - Standard for water tank for Private Fire Protection
- NFPA 24 – Installation of Private Fire Service Mains & Their Appurtenances
- NFPA 25 – Standard for the Inspection, Testing and Maintenance of Water Based fire protection system
- NFPA 30 – Flammable and Combustible Liquids Code
- NFPA 70 – National Electric Code
- NFPA 72 – National Fire Alarm Code
- NFPA 321 – Classification of Flammable and Combustible Liquids
- NFPA 2001 – Clean Agent Fire Extinguishing System
- FM Global Property Loss Prevention Data Sheet
- NFPA 17 – Dry Chemical Extinguishing System
Indonesia Standard Code and Regulations:

- Standar Nasional Indonesia (SNI) 03-3989-2000 – Fire Sprinkler System
- Standar Nasional Indonesia (SNI) 03-1745-2000 – Stand Pipe & hose system
- Standar Nasional Indonesia (SNI) 03-1756-1989 – Portable extinguisher system
- Standar Nasional Indonesia (SNI) 03-1746-2000 – Safety access
- Standar Nasional Indonesia (SNI) 03-6570-2001 – Fixed fire pump installation
- Standar Nasional Indonesia (SNI) PUIL_2000 – General Requirement for Electrical Installation
- Indonesia Building Act No.28 (Undang-Undang No. 28 Tahun-2002 – Bangunan Gedung UUGB)
Fire Protection System Design
Passive protection system

• Building construction material
  – (low combustible, i.e. concrete, internal open space lay out, fire proof ceiling,
Passive protection system

- Building Layout in regard to fire prevention spreading
Passive protection system

- Evacuation access,
Passive protection system

- Site Plan,
Passive protection system

- Electrical Power,
Active protection system

- Fire Detection and Alarm system,
• **Automatic Fire Protection system**
  - Fire Sprinkler System
    - Water Based
      - Fire Water Sprinkler system
        » Wet Pipe Sprinkler system – most popular, low – margin error
        » Dry pipe sprinkler system - When there is the potential for freezing
        » Water mist system – effective on protection for sensitive equipment
Active protection system - Water Based

**Pre-action System** – computer room
- This system requires a preceding fire detection
  - Non-Interlock (active on detection or heat response spr.)
  - Single Interlock (A fire detector initiates the deluge valve, water in piping, sprinkler fuse to activate sprinkler)
  - Double Interlock (active only when both the dry pilot actuator and the solenoid valve are open at the same time)
• Deluge Systems – high-risk equipment and are not vulnerable to water damage (open sprinkler)
Active protection system

• Automatic Fire Protection system
  – Fire Sprinkler System
    • Chemical Based
      – High Expansion Foam Systems - Class A ordinary combustibles, confine areas
      – Low Expansion Foam Systems - Class B, large area
      – Clean Agent Systems - extinguishing Class A, B, and C (electrical)
      – Carbon Dioxide Systems (effective in suppressing Class B flammable liquid
      – Condensed Aerosol Systems
• P&ID Fire Hydrant system drawing
• Fire Hydrant Site Plan Layout drawing
• Fire Hydrant in the building layout drawing
• Section and Detail Fire Hydrant including isolation valve, hydrant box, pipe support
• Fire Pump Room Installation Layout Drawing
• Fire Water Tank and Fire Pump Room Installation Detail and Drawing
Technical Specification Hydrant

• Providing Technical specification for fire hydrant system on each equipment i.e. Fire pump, jockey pump, Valves, Hydrant pipe and fitting, Pillar hydrant, hoses. Etc.

• Providing Costumer Requirement Specification for Fire Hydrant Installation Works

Basis Of Design

Bill of Quantity and Cost estimate

• Add products/equipement cost, and installation cost into BoQ. Equipment cost and component cost are taking from the vendor requisitions
Fire Hydrant System Testing And Commissioning

- check list for pre-commissioning for Pumps, Valves, piping, hydrant in accordance with NFPA 25
- Advise on fire pump/jockey pump set pressure adjustment (if required to be adjusted)
- Check pump performance based on test against the pump curve from pump manufacturer
ASSESSMENT FOR EXISTING FIRE HYDRANT FACILITY

- Existing installation at fire pump room:
  - Fire pump type, capacity, head, model
  - Suction and discharge piping diameter check
  - Suction and discharge pressure
  - Standby set pressure check for main ring hydrant, Operation Set pressure check for fire pump
  - Jockey pump set pressure check as well as capacity
  - Safety Valve set pressure
  - Piping and valves arrangement
  - Fire water tank arrangement and capacity
  - Incoming fresh water pipe and flowrate
  - Water level gauge
Assessment for existing fire hydrant facility

• Existing installation at fire Hydrant Installation Check
  – Pipe size, number of hydrant as well as hose/hoserel
  – Number of bend, tee valves to the most remote Hydrant

• Existing Plant Hazardous Classification Check
  – To find the most hazard class as a reference to determine
    flowrate and pressure at the fire pump

• Hydraulic Calculation for Existing Installation
  – Performing Hydraulic Calculation in accordance fire code
    and standard to ensure that the existing fire pump and fire
    hydrant distribution system whether still sufficient or not to
    supply new or for future fire water supply
ASSESSMENT FOR EXISTING FIRE PROTECTION FACILITY

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Fire Hydrant Layout Site Plan
Alternative 1
Gridded Piping Network

ESFR, K Factor 22.2, pressure at point 2.8 bar
Number of calculated sprinklers: 12 pcs sprinklers
Internal Sprinkler Ring Main Diameter: 150mm
Each Branches/Gridded: diameter 65 mm
Alternative 2
Tree Piping Network

ESFR, K Factor 22.2, pressure at point 2.8 bar
Internal Ring Main Diameter: 200 mm
Number of calculated sprinklers: 12 pcs sprinklers
Each of half Branch Line has piping configuration:
100 - 100 - 100 - 100 - 80 - 65 mm
Down pipe to sprinkler: 50 mm
Alternative 2
Tree Piping Network (zoom view)
Hydraulic Simulation

Alternative 1_Gridded system
Branch pipe line dia. 65mm

Simulation to trim the pipe
(Tree piping network, use 65mm at branch line)

The result shows the Red pipe:
- Pressure drop: high >7 barg
- Velocity: high >10m/s
- Inadequate flowrate

Simulation to trim the pipe
(Tree piping network, use 100 mm at branch line)

Result:
There is not red pipe shown in the modeling, means with diameter 100 mm at branch with tree network, the hydraulic system is acceptable. (Pressure drop, velocity, flowrate are according to the standard.)
Isometric - Node Number
Isometric – Density mm/min
Isometric – Pressure
Isometric – Velocity
Hydraulic Calculation for the Fire Sprinkler System for Cikedokan Site

AIM:

Determine the greatest water demand, pipe size dan pump capacity for Fire Sprinkler System

Sheet | Title
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1 | Cover Sheet
2 | Assumption
3 | Summary Sheet
4 | Calculation
5 | Isometric - Node Number
6 | Isometric - Density
7 | Isometric - Pressure
8 | Isometric - Velocity

Conclusions

K factor for ceiling spr warehouse: $11.2 \text{ gpm/psi}^{1/2} = 160 \text{ lpm/bar}^{1/2}$

K factor for In-Rack sprinkler: $11.2 \text{ gpm/psi}^{1/2} = 160 \text{ lpm/bar}^{1/2}$

Minimum density: 17.778 mm/min
Maximum velocity: 5.55 m/s
Minimum pipe size: 50 mm (at the branch pipe/gridded)
Maximum pipe size: 200 mm (at main sprinkler pipe)
Water demand is 6108.7 L/min, pressure 6.4 bar (for total Ceiling sprinkler and In rack spr)
Purpose
Determine the greatest water demand, pipe size dan pump capacity for Fire Sprinkler System.

References
Fire Sprinkler System reference:
- AS 2118.1—2006 Automatic fire sprinkler systems Part 1: General systems
- Coca-Cola Amatil Insurance Fire Protection Guidelines
- AS 4118.2.1. Fire Sprinkler System, Piping - General

Assumptions
General Assumption
1. Fire sprinkler calculated base on the highest hazard and the longest length from the source/pump
2. Sprinkler at building no. 16 as a reference for hydraulic calculation
3. Building No. 16 assume will store contain of empty bottle plastic and cartoon in the storage rack
4. Building No. 1 (Production Area) assume has a same fire hazard with building 16 and building 17
5. The fire occupancy in the building 1, 16 and 17 is High Hazard Category 5
6. Storage tank for sprinkler system assumed to build new storage tank and pump, above ground

Specific Assumption
1. Most unfavorable area is applying for water demand calculation.
2. Sprinkler pipe assumed using API 5L Sch. 10. (background is AS std. 4118.2.1, table 3.1.2,
   - Testing pressure for dia. 200mm shall minimum 64.9 bar)
3. Elbow welded above 65mm
4. Specific gravity 1
5. Maximum velocity allowable is 6 m/s
6. For the ceiling sprinkler, except pre action, sprinkler pipe configuration using Gridded
7. Distance between sprinklers on High hazard category 5 area is 3m
8. Maximum storage height in Warehouse is 7.6 m, aisle is 1.6m, without solid shelves

Methodology
a. Calculation to select sprinkler type is using excel sheet
b. Hydraulic calculation using software AACalc 7
c. The final sprinkler type is to be used for an input in hydraulic calculation software as a reference
d. Main sprinkler pipe length is measured from site plan drawing (from source to tap point)
e. Water demand is using the figure from output hydraulic calculation.
f. The velocity in the pipe will be maintain not more than 6 m/s, if more than that, adjust pipe size.
g. The total pressure required from the source is maintained not more than 12 bar, if more than that, re adjust the pipe size.
Water demand

Compartment Category 5, without solid shelves

Height of rack storage = 7.6 m
Clear aisle = 1.6 m (assumed, required appropriate data)
Design Density = 12 mm/min (table 11.6.4 ML) (minimum density)
Number of level in rack sprs. = 2 (table 11.6.4 ML)
Design Area = 185 m² (table 11.6.4 ML)
Maximum Roof/ceiling height = 14 m
Operating spr. under non solid floor = 14 pcs (table 11.5.12.2)

Flow Operating spr. under non solid floor = 114 l/min per piece (table 11.5.9.9)

Water demand

Roof/ceiling demand = design density / design area
= 22.29 l/min

In rack ceiling demand = number of operating in rack sprinkler x flow in rack sprinkler
= 1596 l/min

Total water demand = 24316 l/min
= 1.008 gallon/min

*Total water demand shall using greatest calculated flow demand of all hydraulically most unfavorable areas of the sprinkler system.

From Hydraulic Calculation of the most unfavorable areas

Water Demand from source = 6308.7 l/min = 6131.92 us gpm
Pressure required = 6.593 bars
Fire Pump Selection = 1700 gpm (horizontal split case)
Duration of Water Supply = 120 minutes
Water Storage Capacity = 772140 lter
= 275 m³

Selection of Sprinkler Type

Ceiling Sprinkler

Minimum Density = 12 mm/min (table 11.6.4 ML)
Max. coverage area per head/ceiling spr. = 9 m² (table 11.4.1.6)
Number of operating ceiling sprinkler = design area / max. coverage area per sprinkler
= 21 pieces (design)

Minimum Flow per ceiling sprinkler = ceiling water demand / number of operating ceiling sprinkler
Q = 108 l/min per piece
Pressure required for each sprinkler (P) = 100 lps
Q = K factor x VP
K factor = Q / VP
Minimum K Factor for ceiling sprinkler = 10.80 lpm/kpa⁻¹²
Install Position = Upright

Selected Nominal K factor = 11.2 gpm/(psi)⁻¹/²
= 150 lpm/psig⁻¹/²

In Rack Sprinkler

Min. Flow Operating spr. under non solid floor = 114 l/min per piece (table 11.5.9.5)
Pressure required for each sprinkler (P) = 100 lps
Q = K factor x VP
K factor = Q / VP
Minimum K Factor for ceiling sprinkler = 11.00 lpm/kpa⁻¹²
Install Position = Pendant

Selected Nominal K factor = 11.2 gpm/(psi)⁻¹/²
= 150 lpm/psig⁻¹/²
Number of In rack sprinklers Hydraulic design = 14 Sprinklers