Fire water demand Calculations Petrochemical facilities

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S Erasmus

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Firewater Demand

1. **Introduction**

- Water Supply, the extent and capacity of the firefighting system and associated equipment for a facility should be based upon the assumption that only one major fire will occur at any one time. Some facilities consider 2 credible Scenarios.
- **Tanks and Reservoirs**
- Limited capacity sources such as tanks and reservoirs can be provided as a source of water. The designs of tanks and reservoirs should be for the minimum judged necessary for fighting fire within the facility. This may be as little as a two-hour supply for a relatively low risk plant, but a minimum of 4-6 hours is typical, based on the largest fire water demand. A maximum refill time of **8-hours is recommended (NFPA 22)**
- Fire water demand calculation of any facility is based on the maximum anticipated demand i.e. the total of the initial fire water demand (IFWD – deluge, water sprays, etc.) and, the sum total of all continuous fire water demand (CFWD – hose-streams, monitor nozzles, foam, etc.) required to successfully handle a fire in that facility plus a 20% safety factor.

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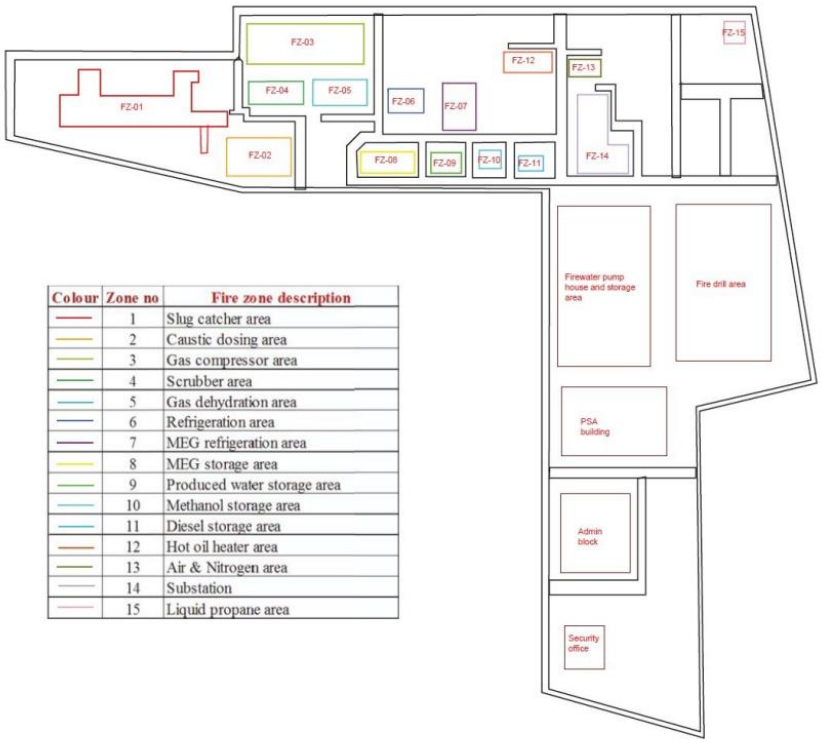
2. Firewater demand

- Where separation of units or hazardous equipment is less than 50 ft (15 m), (30m) the combined area should be considered as a single fire area. If the design water flow rate for the process unit requiring the largest flow is less than the requirement for the largest tank or group of tanks, **the tank protection demand** should become the design basis.

- The firewater system should be designed in such a way that the total demand calculated will be maintained at the outlets with a minimum required pressure.(800kpa-1200kpa) The firewater distribution piping shall be designed in such a way that water flows evenly to all parts of the network and shall be able to isolate any section of a network without affecting other loops.

Fire case study



Colour	Zone no	Fire zone description
	1	Slug catcher area
	2	Caustic dosing area
	3	Gas compressor area
	4	Scrubber area
	5	Gas dehydration area
	6	Refrigeration area
	7	MEG refrigeration area
	8	MEG storage area
	9	Produced water storage area
	10	Methanol storage area
	11	Diesel storage area
	12	Hot oil heater area
	13	Air & Nitrogen area
	14	Substation
	15	Liquid propane area

Fig.2. Fire Zone Delineation

- **3.Firewater Demand Calculation**
- In this case study the firewater demand was calculated for two fire scenario
- Largest two firewater demand are in Fire zone-01(Slug catcher area) and Fire zone03(Gas compressor area)
- Thus Fire Water Demand Calculation for the selected case study is as follows:

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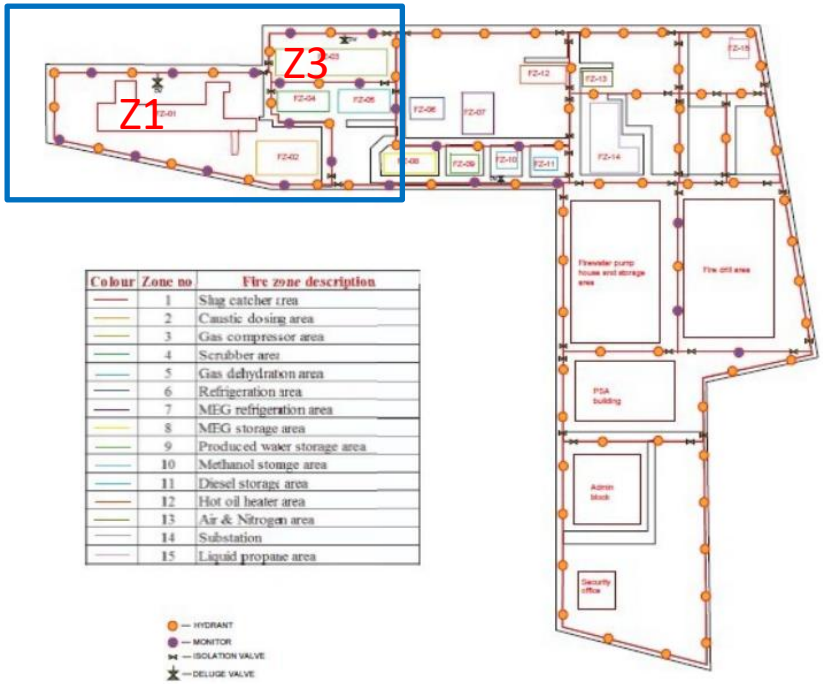

- **3.4. Firewater Network Hydraulics**
- The hydraulics is done by taking in to account that;
- Maximum velocity in the firewater network should not exceed 5 m/s
- The minimum available pressure at the remotest point shall not fall below 7 Bar.
- Demand calculated was 1895 m3 /hr. The firewater network is sized 120% of the required water demand i.e. 2274 m3 /hr.
- The network hydraulics is done for two major fire scenarios. Gas compressor area and Slug catcher area

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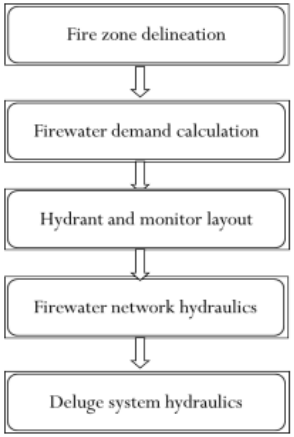
- The two major demand are in Gas compressor area and Slug catcher area

METHODOLOGY

The methodology to design the firewater network involves the following steps.



Demand for slug catcher area and Supplementary stream	550.8 + 372 = 922.8 m3 /hr
Demand for Gas compressor area and Supplementary stream	600 + 372 = 972 m3 /hr
Total firewater demand	1895 m 3 /hr
Firewater pump capacity (3 pumps)	680 m3 /hr
Total pumping capacity 50% standby pumps x2	2040 m3 /hr
Firewater storage capacity 2040 x 4	8160 m3

- For hazardous area provide hydrant post for every 30 m around the plant and for building and utility area provide hydrant post for every 45 m (60m) (90m).
- Hydrants should be placed at 15m-30m from the edge of storage tank and hazardous equipment.
- A minimum of 2 monitors shall be provided for the protection of each such area.
- Monitors should not be installed less than 15 m from hazardous equipment and maximum 45m from the area to be protected.

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Table 8-7
Sprinkler Protection for Medium to Small Processing Facilities

Flash Point	Heated To/Above Flash Point	Room or Equipment Explosion Hazard	Sprinkler Density gpm/ft² (lpm/m²)	Sprinkler Temp. Rating °F (C)	Area of Demand ft² (m²)	Manual Hose Streams gpm (lpm)	Duration min
Any liquid presenting explosion hazard			0.30 (12)	286 (141)	6,000 (560)	1,000 (3800)	120
				165 (74)	8,000 (740)		
<100 °F (38 °C)	Does Not Apply	No	0.30 (12)	286 (141)	4,000 (370)	5000 (1900)	60
				165 (74)	6,000 (560)		
100–200°F (38–93 °C)	Yes	No	0.30 (12)	286 (141)	4,000 (370)		
				165 (74)	6,000 (560)		
	No	No	0.25 (10)	286 (141)	4,000 (370)		
				165 (74)	6,000 (560)		
>200 °F (93 °C)	Yes	No	0.25 (10)	286 (141)	4,000 (370)		
				165 (74)	6,000 (560)		
	No	No	0.20 (8)	286 (141)	3,000 (280)		
				165 (74)	4,000 (370)		

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- Process and fire water systems should be separate. Permanent connections between the fire water system and any process system shall be prohibited, to prevent contamination of fire water with process fluids. If extraordinary circumstances require the systems to be temporarily connected the design should ensure the minimum fire water flow rates and total volume demands.

Table 1—Example Water Flow Rates for Manual Firefighting[a]

Scenario Area of Interest	Fire Water Flow Ranges, per Minute in Thousands of Gallons (thousands of liters)	Example Flow Rate Ranges Based on Protected Area (gpm/ft^2 or Lpm/m^2)
Radiant heat protection		0.1 gpm/ft^2 (4.1 Lpm/m^2)
Process Areas—Handling flammable liquids or high-pressure flammable gases	4000 gpm to 10,000 gpm (15,000 Lpm to 38,000 Lpm)	Cooling: 0.2 gpm/ft^2 to 0.3 gpm/ft^2 (8.2 Lpm/m^2 to 12.3 Lpm/m^2) Suppression: 0.3 gpm/ft^2 to 0.5 gpm/ft^2 (12.3 Lpm/m^2 to 20.4 Lpm/m^2)
Process Areas—Handling gases or combustible liquids	3000 gpm to 5000 gpm (11,000 Lpm to 19,000 Lpm)	0.20 gpm/ft^2 to 0.30 gpm/ft^2 (8.2 Lpm/m^2 to 12.3 Lpm/m^2)
Tank Storage—Flammmable and combustible liquids in atmospheric tanks	0.16 gpm/ft^2 to 0.3 gpm/ft^2 (6.5 Lpm/m^2 to 13 Lpm/m^2) (application rate increases with tank diameter)	See API 2021 and NFPA 11
LPG Storage—Tanks and vessels[b]		See API 2510, API 2510A, and NFPA 58 (250 gpm to 500 gpm at point of impingement by a high-velocity jet flame—API 2510A)
Warehouses		See applicable *Building and Fire Codes*
Buildings—Offices, laboratories, and similar structures		See applicable *Building and Fire Codes*

[a] The total (gpm or Lpm) flow required will depend on size, congestion and the needs of the exposed facilities being protected. The specific flow rate (gpm/ft^2 or Lpm/m^2) chosen will depend on the definition of the fire area and the fuel loading in the area. Flow rates required for full surface jumbo tank fires often exceed 10,000 gpm (see 6.2.2.6 and API 2021).

[b] Do not extinguish gas fires until the source of gas can be isolated.

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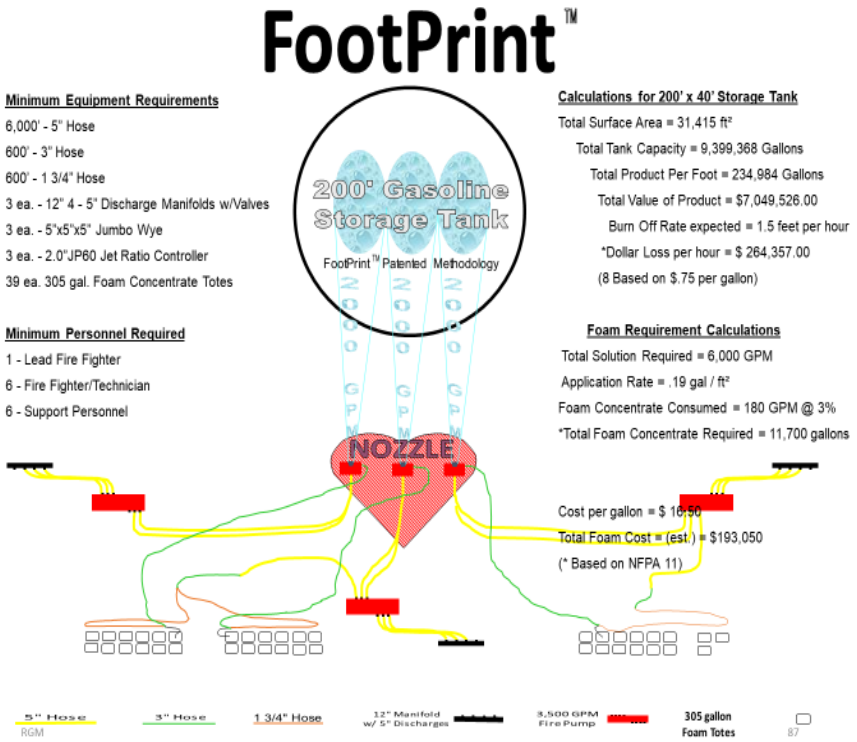

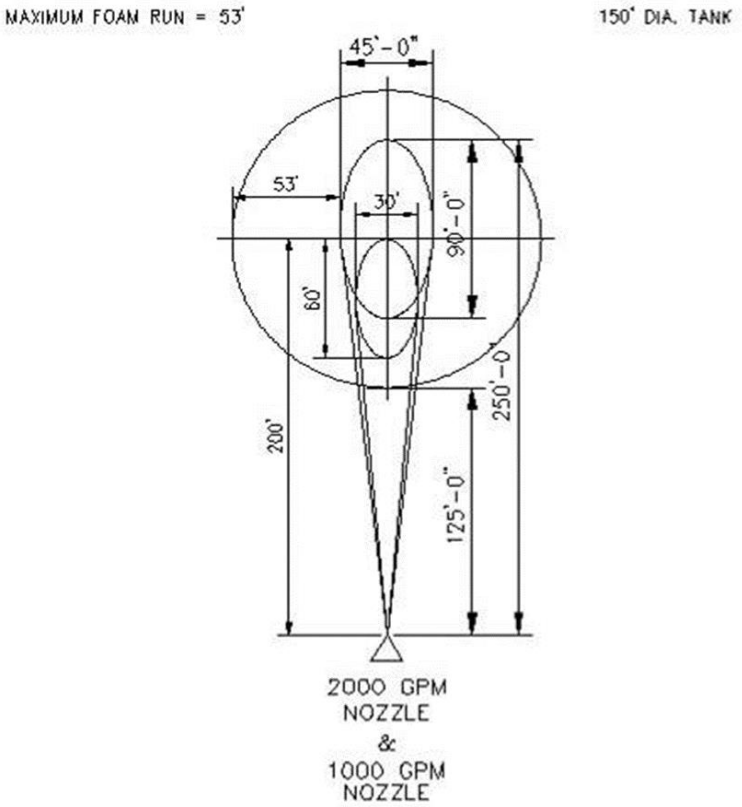

Notes

7571l/min x 3 = 22 713l/min **total surface area 9580m2 tank**

1363m3/h **20% safety factor = 6 542 400 l storage tank (4hours)**

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Reference codes and standards

- *GAP.14.1.1.1 Estimating Fire Protection water demands for chemical plants.*
- *NFPA 11 Standard for Low-, Medium-, and High Expansion Foam*
- *NFPA 15 Standard for the Water Spray Fixed Systems for Fire Protection*
- *API 2001 Fire Protection in Refineries*
- *API 2030 Application of Fixed Water Spray Systems in the Petroleum Industry*
- *API 2218 Fireproofing Practices in Petroleum and Petrochemical Processing Plants*