No. D02-105

FIRE PROTECTION, EXTINGUISHMENT

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Enbridge Pipelines Inc.

Lakehead Pipe Line Company, Inc.

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1. SCOPE

1.1 Intent

This standard provides the design and installation requirements for the application of fire protection systems to the transportation, metering, and storage of crude oil, natural gas liquids, and petroleum products. It includes the requirements for materials, design, procurement, manufacture, inspection, and testing. The fire protection systems presented in this standard include only the system design and installation parameters of the equipment required for fire extinguishment. Fire, vapor detection, and alarms are presented in separate standards.

1.2 Responsibility

This standard presents a variety of fire protection system descriptions, in addition to Company requirements, and shall be used in conjunction with the following codes and other related standards listed in Clause 2. This standard does not apply retroactively:

a. National Fire Code of Canada (for Canada); and

b. National Fire Codes, a Compilation of NFPA Codes, Standards, Recommended Practices, Manuals and Guides (for USA and Canada).

The Project Engineer shall specify the degree of complexity or functionality of the fire protection system, prepare design specifications, and identify the parameters that govern the selection of fire extinguishing components for a given application.

2. RELATED STANDARDS AND DEFINITIONS

2.1 Company Standards

D02-104	Hazardous Area Classification
D04-102	Painting, Coating, and Lining
D05-101	Berm, Containment
D08-101	Oil Storage Tank
D08-102	Oil Storage Tank, Roof
D08-103	Oil Storage Tank, Accessories
D08-201	Underground Storage
D12-202	Gas Detection
D12-203	Fire Detection

2.2 Regulatory Standards

Canada:

Government of Canada, National Energy Board Act, Onshore Pipe Line Regulations

USA:

Title 49 - Transportation; Chapter 1 - Department of Transportation (DOT); Part 195 - Transportation of Hazardous Liquids by Pipeline

2.3 Industry Standards

The most recent edition shall apply.

ANSI/AWWA D100	Water Storage, Welded Steel Tanks
ANSI/AWWA D110	Wire-Wound, Circular Prestressed Concrete Water Tanks
ANSI/AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inch through 12 Inch for Water Distribution
API Spec 12D	Specification for Field Welded Tanks for Storage of Production Liquids
API Std 650	Welded Steel Tanks for Oil Storage
AWWA D102	Painting Steel Water-Storage Tank
CAN/CSA B137.3	Rigid Polyvinyl Chloride (PVC) Pipe for Pressure Applications
FM 7-88	Loss Prevention Data - Storage Tanks for Flammable and Combustible Liquids
NFPA 10	Portable Fire Extinguishers
NFPA 11	Low Expansion Foam
NFPA 11A	Medium- and High-Expansion Foam Systems
NFPA 11C	Mobile Foam Apparatus
NFPA 12	Carbon Dioxide Extinguishing Systems
NFPA 13	Installation of Sprinkler Systems
NFPA 14	Installation of Standpipe and Hose Systems
NFPA 15	Water Spray Fixed Systems for Fire Protection
NFPA 16	Deluge Foam-Water Sprinkler and Spray Systems
NFPA 20	Centrifugal Fire Pumps
NFPA 24	Installation of Private Service Mains and Their Appurtenances
NFPA 30	Flammable and Combustible Liquids Code
NFPA 37	Installation and Use of Stationary Combustion Engines and Gas Turbines

2.4 Definitions

Term	Definition
Boiling Point	The temperature at which a liquid exerts a vapor pressure of 101.3 kPaA (14.7 psia).
Class IA Liquid	A flammable liquid having flash points below 22.8°C (73°F) and a boiling point below 37.8°C (100°F).
Class IB Liquid	A flammable liquid having flash points below 22.8°C (73°F) and a boiling point at or above 37.8°C (100°F).
Class IC Liquid	A flammable liquid having flash points above 22.8°C (73°F) and below 37.8°C (100°F).
Class II Liquid	A combustible liquid having flash points at or above 37.8°C (100°F) and below 60°C (140°F).
Class IIIA Liquid	A combustible liquid having flash points at or above 60°C (140°F) and below 93°C (200°F).
Class IIIB Liquid	A combustible liquid having flash points at or above 93°C (200°F).
Combustible Liquid	A liquid having flash points at or above 37.8°C (100°F), known as Class II, IIIA, and IIIB liquid.
Fixed Foam System	Similar to a semi-fixed system, except that the foam unit is housed inside a building and is permanently connected to the users with hard piping.
Flammable Liquid	A liquid having flash points below 37.8°C (100°F) and vapor pressure not exceeding 2068 mm Hg (40 psia), known as Class I liquid.
Flash Point	The minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid within a vessel as specified by a particular test procedure.

Mutual Aid	An organization formed by neighboring industrial or commercial companies in order to assist each other during emergencies.
Semi-Fixed Foam System	A system that uses a mobile foam unit moved to the location of the fire and temporarily connected to the fixed laterals feeding foam to end users.

2.5 Abbreviations

AFFF	Aqueous Film Forming Foam
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
CSA	Canadian Standards Association
FE	Flow Element
FF	Flat Face
FFSO	Raised Face Slip On
FFWN	Flat Face Weld Neck
FI	Flow Indicator
FM	Factory Mutual
IRI	Industrial Risk Insurer
NBC	National Building Code of Canada
NFC	National Fire Code
NFPA	National Fire Protection Association
NPS	Nominal Pipe Size
OS&Y	Outside Stem and Yoke
PCV	Pressure (Surge) Control Valve
PE	Plain End
PLM	Pipe Line Maintenance
PRV	Pressure Regulating Valve
PVC	Polyvinyl Chloride
RF	Raised Face
RFSO	Raised Face Slip On
RFWN	Raised Face Weld Neck
SCRD	Screwed
SMLS	Seamless
SS	Stainless Steel
TBE	Thread Both Ends
TXMPT	Tube by Male Pipe Thread
TXT	Tube by Tube
TXTXT	Tube by Tube by Tube
UL	Underwriters Laboratories
ULC	Underwriters Laboratories of Canada

3. DESIGN PROCEDURE SUMMARY

a. In consultation with Operations representatives, review the classification of hazardous areas and determine the appropriate fire protection system, or combination of systems, for the required application.

b. Review any appropriate recommendations of the insurance underwriter and discuss possible remedies/solutions with Operations, Safety, Engineering, and maintenance personnel of the Company.

c. In the case of upgrading existing facilities, review the modification and upgrading from technical, practical, and economic points of view. Consultation with the manager of the Tax and Risk Management Department may be required.

d. For the design of a firewater system, determine the water flow rates based not only on hose-down requirements, but also the requirements for foam application, wet system, and deluge system.

e. For the design of a firewater system, review possible pressure ranges for full flow conditions. At locations where hose stations will be manually handled, ensure pressures will not exceed 690 kPa (100 psi). Pressures at monitors and foam systems must be sufficient, however, to deliver the design flow.

Comment: *This review is especially important if components of the firewater system are located at significant elevation differences.*

f. For foam systems, ensure the correct type and quantity of foam is specified.

Comment: *Mixing of AFFF and fluoroprotein will result in pluggage of the foam system. The Project Engineer should check and consider use of the same type of foam used by neighboring Mutual Aids.*

g. Confirm with the local fire department and Mutual Aid that common types of hose thread and pumper truck connections are used.

h. Ensure the fire protection facilities are designed, supplied, erected, and tested in accordance with the appropriate code requirements, and that they comply with the guidelines of this standard. Most components shall bear the label of UL (ULC in Canada) or FM.

i. Ensure the following considerations, when applicable, are addressed:

- **i.** site survey;
- **ii.** geotechnical investigation;
- **iii.** detail engineering design;
- **iv.** reservoir construction;

v. tank fabrication;
vi. general construction;
vii. building fabrication and erection; and
viii. cathodic protection.

4. DESIGN

4.1 Design Philosophy

4.1.1 General

Due to the flammable nature of the hydrocarbon liquids transported within the Enbridge system, potential fire hazards exist, primarily at above ground facilities, from the point where the oil is received through the required operational handling process, including metering, terminaling, and pumping, to eventual delivery out of the system. Oil in storage is ranked as a significant fire hazard because of the appreciably large volumes, the presence of a potentially flammable mixture of gas and free oxygen at the top of the tank, and the possible occurrence of sparking from static electricity or lightning. Other high risk areas are failed or leaking mechanical pump seals, valve bodies or stem packing, flanges within manifold installations, and catastrophic failure of a containment system (pipe, tanks, etc.).

All equipment and facilities should be designed and installed to minimize potential fire hazards. As well, fire-extinguishing facilities should be in place to minimize the loss in case of fire. The most effective fire extinguishing system or combination of systems should be chosen, depending on the hazardous location and type of equipment to be protected. Operations should be consulted regarding site specific protection requirements. Redundancy, whenever possible, should be provided in high-risk areas. Refer to Figure 6.1: Fire Extinguishing Systems and Applications, for various systems and their applications.

Sizing of the system shall be based on a single occurrence of the largest potential hazard. For oil storage tankage, as an example, the system shall be sized to protect the largest tank. Refer to Clause 4.2.1 in this standard for specific system sizing criteria.

Generally, the insurance broker or underwriter can provide very useful technical input regarding the adequacy of existing fire protection systems and the design parameters of proposed new installations or facility modifications. Their engineering representatives are normally prepared to review such information as part of their service, and Project Engineers should attempt to obtain their assessment and recommendations. The Project Engineer is not obligated to incorporate any design recommendations obtained in this manner; however, if significant deviation is suggested, input from the manager of the Tax and Risk Management Department regarding premiums and potential insurability should be obtained.

This standard is based on the recommendations and requirements of national fire codes, and should be followed, with modifications, to suit site specific conditions or the local environment. Within urban areas, the qualified fire marshal should be consulted regarding compliance with local or regional fire safety regulations. The Project Engineer must then decide or, perhaps, negotiate the applicability of any locally proposed design changes.

4.1.2 Tank Fire Protection

In order to isolate the fire from the source of free oxygen, tank fire protection shall be achieved by the provision of foam application from the top of the tank to blanket the burning oil. The capability to cover any spilled oil with foam should also be provided. Fighting a tank fire will only be allowed from outside the tank berm.

In general, it shall be Company policy to provide sufficient firewater, in terms of pressure and volume, to protect and cool the site tankage through a properly distributed network of hydrants, in accordance with accepted industry practice. Refer to Clause 4.2.1 for specific system sizing criteria.

Using hydrant mounted monitors, actual application of cooling water to the tank shell may or may not be possible, and is beyond the scope of Company personnel fire fighting capabilities. It is recognized that external personnel, such as local fire departments, and supplemental means may be required for effective tank shell cooling.

The subsurface injection method, which involves injection of foam directly into the crude at or near the bottom of the tank, has been determined to be ineffective and is not a recommended installation.

4.1.3 Equipment and Building Fire Protection

For other facilities, fire protection methods shall be suitable to the locations and source of fire, taking into consideration the availability of fire fighting medium and the effectiveness of the medium on the type of fire. In general, foam should be used for oil fire, and water for cooling and nonelectrical fires. $C0_2$ or halon shall be used in control rooms and electrical facilities where cleanup of fire fighting medium after the fire will present a problem.

Comment: *Although halon is a fluorocarbon and, as such, is harmful to the earth's ozone layer, at present it is the most effective and safe method of inert gas extinguishment. Development of an effective, nonharmful replacement is ongoing.*

4.1.4 Manned and Major Facilities

When the facilities are manned full time and a shutdown will affect the entire oil movement system, a full scale fire protection system, as indicated by Figure 6.1: Fire Extinguishing Systems and Applications, should be considered. This includes major pump stations and terminals.

4.1.5 Remote Facilities

For remote and unmanned facilities, when shutdown of equipment will not affect the oil movement system, the fire protection can be limited to portable fire extinguishers. These locations will require remote fire detection and isolation; refer to Engineering Standard No. D12-203: Fire Detection. If, however, oil storage tanks are located in the remote locations, a suitable form of tank fire protection should be considered.

4.1.6 Consideration for New Installation

Fire extinguishment is the last resort for protection of property and facilities. Any new installation shall be designed to minimize the fire hazard and to incorporate the most recent design guidelines, technology, and codes of fire safety. Early consultation with the Company's Safety and Environment Department and the insurance broker or underwriter is advisable prior to detail design. To ensure compliance with local fire codes or bylaws, it is advisable to review the design with a technically qualified fire marshal prior to procurement and construction.

Comment: *When the facility is located in a rural area, the fire marshal or captain may simply be a volunteer and, therefore, unable to provide meaningful technical input.*

4.1.7 Modifications of Existing Facilities

When undersized or obsolete facilities require upgrading or possible replacement to meet current codes and guidelines, both the insurance broker and the local fire marshal should be consulted. If there is doubt that a current system is capable of providing sufficient coverage, testing of flow and pressure should be conducted to provide data for evaluation and potential upgrading.

4.1.8 Methods of Fire Extinguishment

There are specific fire protection methods to suit the various requirements of an oil pipeline system. In conjunction with the following, refer to Figure 6.1: Fire Extinguishing Systems and Applications.

a. Firewater System

A firewater system provides water for the purpose of flame suppression, cooling of structures and equipment to prevent structural collapse or failure, and preventing the spread of fire to adjacent facilities. Firewater is also used as a prime ingredient of the foam solution and a source of water for the wet system (sprinklers) and deluge.

For locations where antifreeze additives are required, propylene glycol or other environmentally nonthreatening and nonflammable equivalent shall be used.

Firewater shall not be used to fight an electrical fire.

Comment: *Water, being electrically conductive, will cause body injuries due to electrical shock and may cause an explosion within the electrical equipment.*

b. Foam System

Foam is the most effective method to extinguish an oil fire by isolating the burning oil from the atmospheric oxygen. The Company generally uses semi-fixed foam systems to deliver a foam/water solution to the source of fire. At the fire ignition surface, the foam/water solution is expanded and mixed with air to form a blanket of foam, which will rapidly disburse and float on top of the oil. The foam method should not be used to fight fires involving miscible liquids (such as alcohol).

c. Wet System

A wet system is a pressurized sprinkler system using firewater and is located inside buildings to protect the contents. The sprinklers are automatic heat sensitive heads. Upon operation, the heat from burning flames will melt the seal of the sprinkler head and distribute the water over the area where the fire is detected. An automatic alarm will be activated simultaneously. For unheated buildings, the sprinkler system will be filled initially with antifreeze to prevent freeze-up in the winter months. Environmentally friendly, nontoxic, nonflammable antifreeze, such as propylene glycol, shall be used. The wet system should not be installed where water cannot be used, such as over electrical equipment.

d. Deluge System

A deluge system is a fixed fire protection system or method that will totally flood an area with firewater (or foam) through open nozzles or sprinklers. The system piping is empty until it is activated by automatic or manual release of a deluge valve. A mobile foam production unit is generally used to supply the foam solution when required.

e. Carbon Dioxide (CO_2) System

A CO_2 system is similar in operation to a deluge system. CO_2 will be released automatically or manually to fill the atmosphere at the detection of fire. It will extinguish fire by reducing the atmospheric oxygen concentration below a combustible level. This method is applicable and advantageous in confined space and in occupancies where an electrically nonconductive medium is essential or desirable, and when cleanup of another medium presents a problem. Halon systems may also be used, since development of an effective replacement is currently under way.

Comment: *The Company has used CO_2 systems to protect pump rooms at some of the original stations where the manned control room is close to the pump room.*

f. Portable Fire Extinguisher

Portable extinguishers are intended as a first line of defense to put out a fire of limited size at its earliest stage. They shall be located in all areas where potential fire hazards exist; refer to Section 2 of the Company's Operating and Maintenance Procedures Manual.

4.2 Firewater System

A firewater system consists of a source of water and the pumping facility to deliver the water to the users (hydrants, monitors, wet system, deluge system, foam, etc.) located in various parts of the property. This is illustrated in Figure 6.2: Schematic of Firewater System, and Figures 6.3A and 6.3B: Typical P&ID of a Firewater System.

4.2.1 Design Criteria

Once the network of hydrants is set up, design data can be established. Flow and pressure shall be assigned to each user.

a. Flow Rate

Flow rates are a function of the size of equipment to be protected. A source of design criteria for storage tanks is found in FM 7-88-1976: Loss Prevention Data - Storage Tanks for Flammable and Combustible Liquids. Refer also to Table 4.1: Minimum Firewater Flow Rates for Oil Storage Tank Fire Protection, and Table 4.2: Minimum Firewater Flow Rates for Other Areas, in this standard.

The design flow rate of the pumping system is not the arithmetic sum of flows throughout the entire property, but rather the highest of the flow rates required to attack a single fire.

For a typical Company tank farm or terminal location, the firewater design flow rate requirement, or "rated capacity", consists of the following:

i. the hose stream requirement for the largest tank at the terminal (involved in fire);

ii. the hose stream requirement for the largest exposed tank; and

iii. the water required to feed the foam proportioning unit.

An adjacent tank shall be considered exposed to nearby fire if the shell-to-shell distance between it and the largest tank is less than one tank diameter.

b. Pressure

The design shall use a minimum of NPS 6 piping, in accordance with NFPA 24. Delivery pressures at the system hydrants shall be within a range of 690 to 860 kPag (100 to 125 psig).

For monitors, the delivery pressure is usually at the high end of the pertinent range and is dependent on the flow.

The Project Engineer shall also take elevations of the entire network into consideration. Part of the network may have to be regulated to maintain delivery pressure to within the range mentioned above.

With the network established, pipe size properly chosen, flow rates, and delivery pressures established, the Project Engineer shall perform an hydraulic analysis to calculate the "rated" fire pump discharge pressure required at the design flow rate. These pressure and flow terms are referred to as rated total head and rated capacity.

c. Source Capacity

The Project Engineer shall ensure that a sufficient volume of water is available at the site to allow the design flow rate to be maintained throughout the following minimum time periods, in accordance with FM 7-88:

i. crude oil and Class I liquids — minimum 4 hr.; and
ii. Class II and Class III liquids — minimum 2 hr.

The water supply shall be sufficient to provide the calculated required storage volume in “live” storage, with an allowance for any dead storage, e.g., tank and reservoir bottom sedimentation and ice buildup in case of an outdoor reservoir.

Table 4.1
Minimum Firewater Flow Rates for Oil Storage Tank Fire Protection

Largest Tank Diameter	**Hose Stream Flow Rate* (For Tank Involved in Fire)**	**Foam Solution** Flow Rate**	**Hose Stream Flow Rate* (For Exposed Tank)**
m (ft.)	1/min. (US gal/min.)		1/min. (US gal/min.)
30 (100)	3800 (1000)	Refer to Note 2	1900 (500)
45 (150)	4750 (1250)	Refer to Note 2	1900 (500)
60 (200)	5700 (1500)	Refer to Note 2	2850 (750)
75 (250)	6650 (1750)	Refer to Note 2	2850 (750)
90 (300)	7600 (2000)	Refer to Note 2	3800 (1000)

Notes: 1) The total firewater flow rate requirement for oil storage tank fire protection is hose stream (largest tank in fire) + hose stream (largest exposed tank) + foam solution.

2) The water flow rate for foam solution is:

a. for steel pontoon or double deck floater: foam solution flow rate = annular area between shell and foam dam (m^2) x 12.3 l/min/m^2 or [ft^2 x 0.3 gpm/ft^2]; and

b. for covered tank with steel pan type floater, nonferrous floater, or without floater: foam solution flow rate = total liquid surface (m^2) x 4.1 l/min/m^2 or [ft^2 x 0.1 gpm/ft^2].

3) Source of data from NFPA 11 (**) and FM 7-88 (*).

Example Find water design flow rate to protect a tank farm when:

— the largest tank at the terminal is 60 m in diameter (200 ft.)

— the distance to the closest adjacent tank is 84 m (275 ft.);

— all tanks have steel pontoon floater with foam dam; and

— space between shell and foam dam is 0.6 m (24 in.).

Due to the adequate spacing, the adjacent tank is not considered exposed.

∴ Minimum firewater flow rate = 5700 + (3.142 x 60 x 0.6 x 12.3) = 7090 l/min.

or: 1500 + (3.142 x 200 x 2 x 0.3) = 1877 gpm.

We would probably specify the design flow rate as 7600 l/min (2000 gpm).

Table 4.2 Minimum Firewater Flow Rates for Other Areas	
Area	**Minimum Hose Stream Flow Rate**
	l/min. (USgpm)
Pump Building	5700 (1500)
Metering	4750 (1250)
Tank Manifold	4750 (1250)
Loading/Unloading	4750 (1250)
Warehouse	4750 (1250)
Maintenance Shop	3800 (1000)
PLM Shop	3800 (1000)
Other Buildings	3800 (1000)

Notes: 1) The above rates shall be used as a guideline only. They are based on protection by outdoor hydrant. As a rule-of-thumb, use 4.1 $l/min/m^2$ ($0.1\ gpm/ft^2$) over the entire area.

2) For the total requirement, add the specific flow rate (for deluge, wet system, foam system, etc.) to the hose stream rate.

d. Pressured System

It is preferred that the entire firewater system be pressurized at all times. Pressurization can be achieved economically with a relatively small jockey pump (40 to 60 l/min [10 to 15 USgpm]). A pressurized system provides assurance that the entire firewater system is functional and is ready to deliver firewater at all times. It safeguards accidental or illegal use of the firewater system. A defective system or breakdown of the system due to freeze-up, mechanical damage, or accumulation of sludge or foreign materials is detected immediately, allowing time for repairs and restoration prior to an actual emergency.

Comment: *The relatively minor cost to operate and maintain the jockey pump is offset by the severe consequence of an inoperable firewater system at the time of need.*

4.2.2 Source of Water

The supply of water, depending on the property location, can be from the following sources.

a. Storage Tank

The storage tank shall be designed and constructed in accordance with one of the following codes:

i. ANSI/AWWA D100
ii. ANSI/AWWA D110
iii. API Std 650
iv. API Spec 12D

For an above ground tank, winterization (by means of heating and insulation) of the tank shall be considered. The internal surface of the steel tank shall be coated to prevent corrosion. An underground storage tank is an acceptable alternative. To prevent organic growth, suitable amounts of oxygen scavengers (such as sodium hydrochloride) shall be added to the water, with water in the reservoir (refer to **b.**) treated similarly.

Comment: *It is necessary to add the oxygen scavenger to an open reservoir on a periodic basis; therefore, advice from environmental experts should be obtained.*

b. Reservoir

When an earth reservoir is used, either a clay or PVC liner shall be used to minimize leakage. In cold climates, freeboard due to ice buildup and the unusable portion of water at the bottom shall be considered as an allowance made for dead storage. Dead storage in the bottom shall be a minimum of 300 mm (12 in.) deep to allow for accumulation of debris, dead leaves, etc. The reservoir bottom shall be checked for cleanliness regularly (a minimum of every 2 years). Suction screen and backflush piping shall be installed. Such steps must also consider environmental effects.

Comment: *Although water treatment is not a requirement of the National Fire Code or the NFPA, treatment for biological growth and other suspended solids should be considered on a site-specific basis. The Project Engineer may also wish to consider treatment for entrained oxygen as a corrosion prevention measure, if carbon steel piping is used.*

c. River, Creek, or Public Water Supply

When a river, creek, or public water supply is used as the prime source of firewater, prior approval from the government authority shall be obtained. When using a public water system, the government authority may not allow direct tie-in for fear of possible contamination of the public water system from the backflow of the firewater. The Project Engineer must determine whether a backflow preventer is sufficient to satisfy local authorities. If not, an air break may be an acceptable alternative.

d. Deep Well

A deep well may be a possible source of water in conjunction with water storage, if the demand flow rate is not high.

The initial fill of tankage or a reservoir can be economically obtained from a river or creek. To make up for leakage and evaporation from the piping system and from storage, water can be supplied from a public water supply or a deep well.

4.2.3 Pumping Facilities

The delivery of firewater from the source shall be accomplished by using a diesel engine driven centrifugal pump and the accessories described below. Refer to Figures 6.3A and 6.3B: Typical P&ID of a Firewater System, for suggested arrangement of pumping facilities.

a. Fire Pump

The diesel engine driven pump shall be designed, manufactured, and installed in accordance with the requirements of NFPA 20. The characteristics of the pump shall be such that:

i. the shutoff head will not exceed 140 per cent of rated head;

ii. the pump shall have a run-out capability of 150 per cent of rated capacity; and

iii. the pump shall produce a minimum of 65 per cent of rated head at run-out conditions.

The Project Engineer shall obtain a copy of the manufacturer's expected pump curve for review prior to purchasing the fire pump.

The pump driver speed shall be controlled by input from a pressure controller, set in accordance with NFPA 20.

The diesel engine shall be equipped with accessories, such as right angle gear box (depending on the pump configuration), diesel fuel tank, silencer, battery and chargers, cooling system, and heat exchanger.

The fuel tank shall be UL or ULC listed for its special application and use. Its construction, installation, and necessary precaution shall be in accordance with NFPA 30 and NFPA 20.

b. Jockey Pump

The jockey pump is a relatively low capacity pump designed to maintain the firewater header pressure. It should be sized to operate infrequently (no more than two cycles/hr.). The jockey pump should also be supplied with its own controller.

c. Flow Measurement

A flow element (FE and FI) shall be installed to provide for capacity testing of individual and combined pumping operations.

d. Makeup

The water level shall be maintained by a secondary source of water (public water supply or deep well) controlled by a level switch.

e. Surge/Relief Control Valve

A surge/relief control valve (PCV) shall be installed on the pump discharge piping. This is a dual function valve. Firstly, it can be set to relieve at the pump shutoff pressure, allowing a minimum flow to prevent pump overheating. Secondly, it is pilot controlled and fully open on pump startup, recycling the entire flow back to the source. It will then close gradually (adjustable within 10 to 60 sec.), redirecting the flow to the main discharge header, thus preventing pressure surge (water hammer). The relief feature is an NFPA requirement. The surge prevention, being good engineering practice, prevents shock to the system.

f. Pressure Regulating Valve

A pressure-regulating valve (PRV) may be required to maintain user delivery pressure within a design range, (e.g., users at great elevation differences).

g. Backflush

Backflush piping shall be provided if the water source is from a river, creek, or reservoir, where a buildup of dirt is expected at the suction screen.

h. Fire Department Connection

Provision shall be made for a fire department connection to the discharge header. The size and type of connection shall be compatible with the local fire department or Mutual Aid.

i. Fire Pump Building

The fire pump building shall be heated and properly winterized to prevent freeze-up. Should water be supplied from a reservoir underground storage or supplemented by a well, a cistern type (basement concrete storage) suction design is an option. A vertical can type fire pump would then be used.

j. Piping Components (Above Ground)

i. All above ground piping and fittings shall be carbon steel, PN 20 (150/125 lb.) rating, and painted fire red; refer to Appendix A: Recommended Piping and Accessories for Above Ground Firewater Service.

ii. All valving and other piping components shall be UL or ULC listed or FM approved.

iii. All carbon steel piping shall be butt weld joined, whenever possible, with a minimum bolted connection. Piping shall be properly supported to minimize movement and vibration. All butt welds shall be visually and radiographically inspected as specified in Engineering Standard No. D03-104: Weld Inspection.

4.2.4 System Layout

The pump building shall be located adjacent to the source of water, with the connection between the source and building winterized, if above ground or buried above the frost line.

For fire protection of oil storage tanks, the hydrants and valves shall be located outside the berm and positioned so that a minimum of three hydrants can protect all sides of a single storage tank. One of the hydrants shall be located within 3 m (10 ft.) of a foam solution connection; refer to Figure 6.4: Fire Protection of Oil Storage Tank. For a hydrant located among closely clustered tanks, the same hydrant can be designated to protect these tanks.

Fire hydrants shall be located near the outside toe of the berm or firewall a minimum of 15.2 m (50 ft.) away from other possible fire sources, e.g., building wall, but not more than 76 m (250 ft.) away due to hose length limits. Each hydrant shall be sized for delivery of 2850 l/min (750 USgpm) with a delivery pressure at the hydrant within the range of 690 to 860 kPag (100 to 125 psig). Pressure at the delivery point (foam maker/chamber) shall be 415 kPag (60 psig) minimum and 690 kPag (100 psig) maximum.

When the service is critical and manning of fire hoses during an emergency may not be possible due to limited manpower, hydrant mounted monitors should be installed on hydrants located to protect metering manifolds, tank manifolds, the pump building, oil storage tanks, and other facilities.

Comment: *It is neither practical nor necessary to equip every hydrant with a monitor, especially for hydrants designated for protection of a variety of equipment and facilities. When hydrants will feed foam generators, installation of a monitor is not desirable.*

The layout of the piping system shall be such that it loops around the users (hydrants, wet system, deluge system) with sections and isolation valves; refer to Figure 6.2: Schematic of a Firewater System. If one section is unusable, due to leakage or damage, it can be valved off for repair and still enable the balance of the system to remain functional. For this reason, the Project Engineer should attempt to minimize the use of laterals.

All valves and hydrants shall be easily accessible from roads, but far enough from the edge of the road to prevent possible damage. A 3 m (10 ft.) radius around hydrants and monitors shall be level, graveled or paved, and unobstructed. In a case where they are exposed to traffic, guard posts shall protect them. Valves and hydrants shall, however, be located outside hazardous areas, e.g., inside the tank dike, which could become inaccessible or dangerous to enter in case of fire.

4.2.5 Fire Loop Components (Buried)

All buried piping and fittings shall be a minimum of NPS 6 PVC, meeting the requirements of CAN/CSA-B137.3 (Canada) and ANSI/AWWA C900 (USA). They shall be Class PN 20 (150/125 lb.) with bell and spigot end connections, FM approved, and UL or ULC listed. The outside dimension shall be cast iron equivalent; refer to Appendix B: Recommended Piping and Accessories for Underground Firewater Service.

The use of carbon steel piping and fittings for underground service shall be minimized. Steel piping shall be internally lined, externally coated and wrapped, and holiday tested for discontinuity of coating prior to burial.

All valves shall be of the indicating type and shall be ULC or UL listed or FM approved for fire service.

All hydrants, monitors, post indicators, etc., shall be ULC or UL listed or FM approved.

All hydrants and monitors shall have dedicated shutoff valves to minimize a system shutdown to replace or repair hydrants/monitors.

The size and type of thread for hose and pumper truck connections on fire hydrants are likely to differ from site to site. They shall be in conformance with those used by the local fire department and Mutual Aid. The Project Engineer shall confirm the size and thread type with the local fire marshal and Mutual Aid prior to the design and procurement of any hydrant, hose, and connectors.

Installation of PVC piping will require special care and attention compared with butt welded carbon steel piping; refer to Figure 6.5: Hydrant Detail, Figure 6.6: Thrust Block Detail, Figure 6.7: Post Indicator Valve Detail, Figure 6.8: Guard Post Detail, and Figure 6.9: Typical Water Main Detail. Proper support of PVC piping is essential to ensure a long and lasting service. Good solid sand bedding is required to support the piping. At every change of direction, including an uphill run, a thrust block of sufficient size shall be placed. All valves and hydrants shall be anchored to minimize possible movement. The piping, valves, and any wetted part shall be below the frost line. Thrust blocks shall be on solid, undisturbed soil. For areas of poor soil condition, particular attention is required to reinforce the piping support. In this case, buried carbon steel piping should be considered in lieu of PVC.

A hydrant mounted monitor and nozzle shall be selected to suit its specific location with the required flow rate, spray pattern, range, and available pressure specified.

All hoses shall have matching connections with hydrants and other users. Ensure that a sufficient quantity of hoses, couplings, nozzles, portable monitor/hydrant wrenches, coupling spanners, coupling gaskets, and necessary hardware are on a hose trailer parked indoors and ready to be put into service, as required.

For hydrants at remote locations and where accessibility by truck is difficult, a hose house shall be installed adjacent to the hydrant. It shall contain a sufficient quantity of hoses, couplings, and other necessary hardware.

The design of the firewater system shall be in accordance with NFPA 14 and 24.

4.3 Foam System

A foam system consists of a foam proportioning unit and a piping/hose arrangement to supply water to the unit and to bring foam solution to the users/dispensers. Refer to Figure 6.4: Fire Protection of Oil Storage Tank, Figure 6.10: Foam System Schematic, Figure 6.11A: Foam Lateral Layout — Typical, Figure 6.11B: Foam Lateral Detail — Section, and Figure 6.11C: Foam Lateral Detail — Elevation. The foam system shall be designed in accordance with this standard and the requirements of NFPA 11, 11A, 11C, and 16.

4.3.1 Foam Proportioning Unit

The preferred method of foam proportioning is by the "backpressure balancing method". Foam concentrate is pumped from a storage container with a positive displacement pump into a ratio controller, which ensures water and foam concentrate are mixed in a predetermined proportion, regardless of variation in water flow rate and pressure. A control valve at the pump discharge will return any excess concentrate back to the storage tank.

Comment: *This method is preferred over the "line proportioner" method, which not only requires high water inlet pressure that is not always available, but also varies the proportion should water flow rate or pressure change.*

4.3.2 Systems

a. Semi-Fixed System

Typically, a foam production trailer is used at Company facilities. In the vicinity, where a mobile foam proportioning unit will be connected to a foam lateral, such as a tank foam or deluge foam system connection, a hydrant shall be made available as a source of water to the foam unit.

The mobile foam unit shall be equipped with a fixed foam monitor, a 1900 litre (500 USg) minimum capacity foam concentrate tank, and shall carry all necessary hoses, portable foam nozzle, hardware, and other supplies ready for emergency use. The foam proportioning pump shall be an engine driven type.

b. Fixed System

When foam requirement is limited to a few locations, a fixed foam unit and permanent piping system can be installed, if it is more economical and efficient.

Comment: *A semi-fixed system is preferred over the fixed system, mainly because of economic and operational advantages. The mobile proportioning unit can be hauled to the location of fire, thus saving the cost of installation and maintenance of a large network of fixed foam piping.*

4.3.3 Foam Solution

Normally, the foam solution of choice shall be a 3 per cent concentrate solution of fluoroprotein; however, the Project Engineer shall specify fluoroprotein rather than AFFF. In selecting foam for new facilities, consideration shall be given to the same type of foam used by the local Mutual Aid and fire department. Dual use of fluoroprotein or AFFF must be avoided, as mixing of the two foam types can cause a plug-up of the foam systems.

Foam concentrate should be stocked in sufficient quantity to fight the single largest fire, usually the largest oil storage tank. It shall also include possible wastage and reserve for a spill fire. As a guideline, it is recommended that 200 per cent of the calculated quantity shall be stocked on site. The concentrate shall be readily available and stored inside a heated building.

Comment: *Fluoroprotein is cost effective, more heat resistant, and nontoxic. It has less skin and eye contact irritation and requires less dilution for safe disposal.*

4.3.4 Lateral Design (Storage Tank)

a. The lateral shall include a connector, valving, and carbon steel piping running from outside the tank dike, directing the foam solution up the tank shell and distributing it to the maker/chambers. Refer to Figure 6.4: Fire Protection of Oil Storage Tanks, Figure 6.10: Foam System Schematic, Figure 6.11A: Foam Lateral Layout — Typical, Figure 6.11B: Foam Lateral Detail — Section, and Figure 6.11C: Foam Lateral Detail — Elevation.

b. All piping shall be above ground and sloped towards the inlet, with the drain valve at low point for drainage to prevent winter freeze-up. Ensure that the foam piping provides a minimum clearance of 4.3 m (14 ft.) above grade to allow traffic around the tank.

c. The connector to the mobile foam unit shall be located 1.2 m (4 ft.) above grade, within 3 m (10 ft.) of a hydrant. It shall have NPS 2½ hose connections to fit the mobile foam unit.

d. For open or fixed roof tanks equipped with steel pontoon floating roofs, complete with mechanical shoe or tube rim seals, the following apply.

i. Install a 600 mm (24 in.) high steel foam dam around the perimeter of the floating roof.

ii. Install the foam maker/chambers at a maximum of 24.4 m (80 ft.) apart, complete with deflectors located just below the roof-to-shell joint.

iii. Should a 600 mm (24 in.) high foam dam not be feasible to install, use a 300 mm (12 in.) high dam. In this case, the maker/chambers shall then be spaced at 12.2 m (40 ft.) apart.

iv. The delivery flow rate of foam solution required is 12.3 l/min/m^2 (0.3 USgpm/ft^2) of the annular area between the shell and the foam dam for a period not less than 30 min.

v. The piping system shall be designed such that discharge pressures and flows will meet the foam maker/chambers manufacturer's specification. The deviation of flows and pressures between any of the foam maker/chambers on a tank shall be within 15 per cent.

vi. The foam maker/chambers shall be National Foam's MBS/MCS-9FR or equivalent.

e. For open or fixed roof tanks with a floating roof design, other than a steel pontoon or double deck type, a floating roof made of nonferrous materials, e.g., aluminum or plastic, without a floating roof, or any floating roof without a foam dam, the following apply.

i. The amount of foam solution required is 4.1 l/min/m^2 (0.1 USgpm/ft^2) of the entire liquid surface of the tank, e.g., full tank roof area, for a duration of 55 min.

ii. The foam maker/chambers shall be National Foam MCS Type A or equivalent. Quantity and spacing shall follow the manufacturer's recommendation.

Comment: *National Foam, being one of the major designers and suppliers of a wide range of standard foam equipment, is quoted throughout this standard. However, should products of other suppliers meet the specification and requirements, they can also be used.*

4.3.5 Foam Protection for Other Equipment

a. Deluge System

A deluge system is typically used inside a building or over equipment installed outdoors.

i. A deluge system is composed of a fixed piping network, which consists of connections for foam solution on one end and nonaspirating standard water sprinklers on the other end, covering the entire floor area or equipment to be protected.

ii. The connection for foam solution shall be an NPS 2½ hose connection that will fit the mobile foam trailer connection. It shall be located at least 15.2 m (50 ft.) away from the source of fire and on the prevailing upwind side of the area.

iii. The piping system shall be galvanized carbon steel.

iv. For a deluge system having in excess of 20 sprinkler heads, an automatic system shall be installed with a fixed foam unit, piping, automatic deluge valve, and a fire detection system.

b. Foam Monitor Systems

Foam monitor systems are designed primarily to protect the pumps, meters, manifold areas, and miscellaneous equipment associated with loading and unloading operations in the event of a spill fire.

i. The foam solution rate of 6.9 $l/min/m^2$ (0.16 $USgpm/ft^2$) of potential spill area shall be used. The minimum application duration is 10 min.

ii. In the design of a foam monitor system, consideration should be given to traffic patterns, possible obstructions, wind conditions, and effective foam nozzle ranges. The appropriate monitors and nozzles must be selected so that the foam can be applied to the entire area protected at the required application rate. The Project Engineer shall also ensure the pressure requirement is normally in the range of 520 to 700 kPag (75 to 100 psig).

iii. When monitor locations are limited, the hazard area can be protected effectively with automatic (electrically driven or water powered) oscillating foam monitors.

c. Portable Foam Nozzles

Handheld type (portable) foam nozzles offer the versatility of protection for a variety of flammable liquid hazard areas. They are especially suited to extinguishing fires within the following:

i. tank truck loading and unloading platforms;
ii. meter/tank manifold areas;
iii. tank farms;
iv. pump buildings; and

v. remote areas not protected by a foam system.

There are two main types of portable foam nozzles. The first type has no proportioner pack. It has a straight handheld nozzle connected to the foam proportioning unit directly or teed into the fixed tank foam line, which supplies a 3 per cent foam solution to the chamber. National Foam A3F-10, JS-10, and PC-31 are acceptable nozzle types.

The second type has a built-in proportioner. Firewater and foam concentrates are connected to the nozzle separately. Proper proportioning of foam concentrate is accomplished by the venturi principle. The venturi creates a suction that draws the foam solution from a container through a pickup tube and into the foam proportioning nozzle itself, where it is mixed with water and air. A National Foam RP-6 nozzle type is acceptable.

4.4 Wet System

4.4.1 General

A wet system is primarily used to protect indoor facilities. It is an integrated system, consisting of an underground connection to the firewater header system and an overhead piping network to deliver firewater to automatic sprinkler heads, positioned to cover equipment and facilities. On sensing heat, a seal in the sprinkler head will break and release a water spray over the fire source to provide cooling of equipment and to smother the flames. Automatic detection and alarm will alert personnel of the fire; refer to Figure 6.12: Wet System, for the schematic of the system. The following criteria shall be followed when designing the wet system.

4.4.2 Design Pressure

Piping shall be hydraulically designed and based on a design pressure of 1200 kPag (175 psig) to deliver the design flow and discharge pressure to suit the sprinkler head used.

4.4.3 Design Flow Rate

The design flow rate shall be based on the requirement of NFPA 13, Figure 2-2.1(b): Density Curve, and Table 2-2.1(b): Minimum Water Supply Requirement.

a. For the pump buildings and other buildings housing equipment handling hydrocarbon, use the curve for EX.HAZ.GP2.

b. For the warehouse, maintenance shop, and PLM shop, use the curve for EX.HAZ.GP1.

c. For the office and other nonhazardous buildings, use the “Light” curve.

4.4.4 Piping

All underground piping shall be PVC piping, in accordance with ANSI/AWWA C900, with bell and spigot joints. All above ground piping shall be galvanized carbon steel piping. All valves and other components shall be ULC or UL listed or FM approved; refer to Appendix A: Recommended Piping and Accessories for Above Ground Firewater Service, and Appendix B: Recommended Piping and Accessories for Underground Firewater Service. Underground PVC piping shall have electric tracer wire installed and shall be brought above grade to enable location for future maintenance or expansion.

4.4.5 Sprinkler Heads

Sprinkler heads shall be standard 13 mm (1/2 in.) orifices with an ordinary temperature class (55 to 77°C [130 to 170°F]).

4.4.6 Code

Design, supply, fabrication, installation, and testing of the wet system shall be in accordance with the requirements of NFPA 13.

4.5 Carbon Dioxide System

4.5.1 General

A carbon dioxide (CO_2) system consists of CO_2 storage containers, discharge nozzles, interconnecting piping network, a control panel, fire detectors, remote alarms, and a manual pull station; refer to Figure 6.13: Carbon Dioxide System. Two alternative systems, total flooding and local application, shall be considered and designed in accordance with the requirements of NFPA 12.

4.5.2 Total Flooding System

This system would flood the entire space with CO_2 to a minimum concentration of 34 per cent. It is applicable when the entire space can easily be enclosed, such as the control room and electrical switchgear building. The flood duration, accounting for assumed leakage, shall maintain the design concentration for a minimum of 20 min. It will require the following:

a. the building or enclosure to be constructed air tight to minimize leakage of CO_2 after discharge;

b. all doors and openings to be equipped with automatic door closers;

c. all air handling units, louvers, and exhaust fans to be shut down completely prior to discharge of CO_2;

d. an evacuation plan to be in place and all occupants of the building or enclosure to be trained to evacuate at the warning (of discharge) alarm; and

e. sufficient breathing apparatuses to be placed at convenient locations.

4.5.3 Local Application System

This system consists of a discharge nozzle mounted in the vicinity or directly over the source of the fire hazard. It should be used when the total flooding system becomes uneconomical or inefficient because the space cannot easily be enclosed, such as an open pump building, or the source of fire hazard is limited and isolated, such as the pump seal.

For the local application system, use the "rate by volume" method to compute the required CO_2 flow rate as presented in NFPA 12.

4.5.4 Code

The design, fabrication, installation, and testing of a CO_2 system shall be in compliance with the requirements of NFPA 12. It shall be designed for surface fire hazard protection.

4.5.5 Piping

Interconnecting piping shall be galvanized carbon steel and all connections shall be threaded. Use seamless A106B piping and A105 steel forging.

4.5.6 Component

All components shall be UL or ULC listed and/or FM approved.

4.5.7 Pressures

Preference shall be given to a low pressure system (2070 kPag [300 psig]); however, should a high pressure system (5860 kPag [850 psig]) prove to be more economical and efficient, it shall be considered.

4.5.8 Detection

Fire detection should be by means of a cross-zone arrangement with a combination of photoelectric and ionization type smoke detectors. If only one type of detector is set off, an alarm will be triggered. When both types are set off, the CO_2 system will discharge, preceded by a discharge alarm. This arrangement will minimize wrongful discharge due to faulty detectors.

4.5.9 Manual Stations

Manual pull stations shall be located at exits of the building or enclosure.

4.5.10 Control Panel

The control panel should be equipped with an abort button to abort discharge of CO_2 in case of a false alarm.

4.5.11 Alarm

The discharge alarm shall enunciate locally and also remotely to the central control area or local fire department.

The alarm shall be activated at least 30 sec. prior to automatic discharge of CO_2 to allow sufficient time for evacuation.

4.5.12 Grounding

The CO_2 system shall be adequately grounded to prevent sparks due to static electricity generated at the nozzles during discharge.

4.6 Portable Fire Extinguishers

4.6.1 CO_2 Extinguisher

For locations like control rooms, computer rooms, or electrical rooms, where electrically nonconductive media are essential and cleanup of media is undesirable, CO_2 hand fire extinguishers shall be used. They shall be in 4.5, 7, and 9 kg (10, 15, and 20 lb.) sizes with squeeze- or trigger-grip type. A CO_2 extinguisher with a metal horn is not suitable for electrical fires.

4.6.2 Dry Chemical Extinguisher

For all other potential fire hazardous areas, dry chemical portable fire extinguishers shall be used. They shall be filled with potassium bicarbonate powder, Purple K, with carbon dioxide or nitrogen propellant. They shall be in 4.5, 9, and 13.6 kg (10, 20, and 30 lb.) sizes.

4.6.3 Location

A portable fire extinguisher should be located within 15.2 m (50 ft.) of equipment to be protected, or as specified in the Company's Operating and Maintenance Procedures Manual. Each extinguisher shall cover no more than 230 m^2 (2500 ft^2).

4.6.4 Accessories

Accessories shall be fitted for outdoor service (low temperature type) with hose and nozzle.

Portable fire extinguishers shall be equipped with a wall mounting bracket gauge to indicate the charge condition and covers or weather shelter for outdoor use.

4.6.5 Code

All portable fire extinguishers shall be supplied in accordance with NFPA 10, suitable for all Class A, B, and C types of fire and ULC or UL listed or FM approved.

5. PROCUREMENT

5.1 Material Specifications, Design Specifications, and Data Sheets

The Project Engineer shall prepare design specifications for the intended fire protection systems, complete with pertinent data sheets listing all information required by the contractor to perform the detail design of the system. Types of information to be included are system type design, flow rates, pressures, area and equipment to be covered, hazardous area classification, fire loop layout, applicable codes, Company standards, testing requirement, materials supplied by the Company, etc.

5.2 Division of Work

5.2.1 Contract

Procurement of fire protection equipment and/or relat4ed systems shall be by a combined Company prepurchased supply and contractor installation contract.

5.2.2 Prepurchased Items

All major materials and equipment shall be purchased by the Company, including:

a. fire pumps and accessories;
b. fire pump control panels;
c. specialty control valves and instruments in fire pump building;
d. hydrants;
e. hydrant mounted monitors;
f. foam maker/chambers;
g. mobile foam proportioning units;
h. foam monitors;
i. foam nozzles;
j. portable fire extinguishers;
k. fire hoses, nozzles, cabinets, reels, and accessories; and
l. all media, including special foam concentrates, CO_2, lubricants, etc.

5.2.3 Related Work

The following work associated with the installation of a firewater system may be supplied through other contracts:

a. buildings;
b. main water supply;
c. final site grading;
d. Company inspection; and
e. nondestructive testing.

5.3 Tender/Inquiry

5.3.1 General

The preparation and administration of the tender inquiry and contract shall be in accordance with the Company's Contract Manual. The following clauses summarize some of the important aspects to be considered by the Project Engineer in preparing the Contract Document.

5.3.2 Contract Document

Review the standard Contract Document. Job description, location details, and construction schedule requirements shall be included to make the standard document applicable to the specific installation. The Project Engineer is responsible for completing the following sections of the Contract Document.

a. Instructions to Bidders;
b. Contract Proposal;
c. Special Conditions; and
d. Description of Work.

The Instructions to Bidders shall request the bidder to provide a detailed work plan.

5.3.3 Drawings

Review the standard drawings as specified in Clause 6, and select those applicable for use in the Contract Document. Specific drawings shall be prepared as required to detail all aspects not covered by the standard drawings.

5.4 Manufacturer's Data and Records

5.4.1 Data For Review

All materials to be either procured by the Company or the contractor shall be supplied with data and material certification of compliance to specification and code requirements. For fire protection equipment and components, the Project Engineer shall look for the UL, ULC, or FM listing/approval. For bulk materials, such as piping, steel plates, and structural steel, the mill test certificates are required.

All these materials shall be designed, supplied, fabricated, and tested in accordance with NFPA and the related code requirement.

The data shall be reviewed and accepted by the Project Engineer prior to fabrication and installation.

5.4.2 Quality Control and Testing

All materials and equipment, which are either procured by the Company or the contractor, shall be inspected and tested in accordance with the specification, as well as code requirements.

The contractor shall also perform quality control and testing of the fire protection systems, as required by the code and the specification, e.g., pressure and leak testing of firewater system, during the course of construction.

Performance and acceptance testing of equipment and the system at completion shall be by the contractor in the presence of the Project Engineer or designate. The contractor shall then certify that the equipment or system has been supplied, erected, and tested in accordance with the specification and code requirements.

All supplier/contractor data related to quality control, inspection, testing, and compliance shall be obtained. The data shall become the property of the Company, specifically, all radiographic film.

5.4.3 As-Built Documentation

A complete set of as-built documentation, including test records certified by a professional engineer experienced in the design of these systems, shall be supplied by the suppliers/contractors at completion of order/construction.

5.5 Guarantee

The suppliers/contractors shall be required to guarantee the materials, workmanship, and design for a period based on the lesser of 18 months from mechanical completion or 12 months from the in-service date.

6. FIGURES

Figures are contained in the following pages.

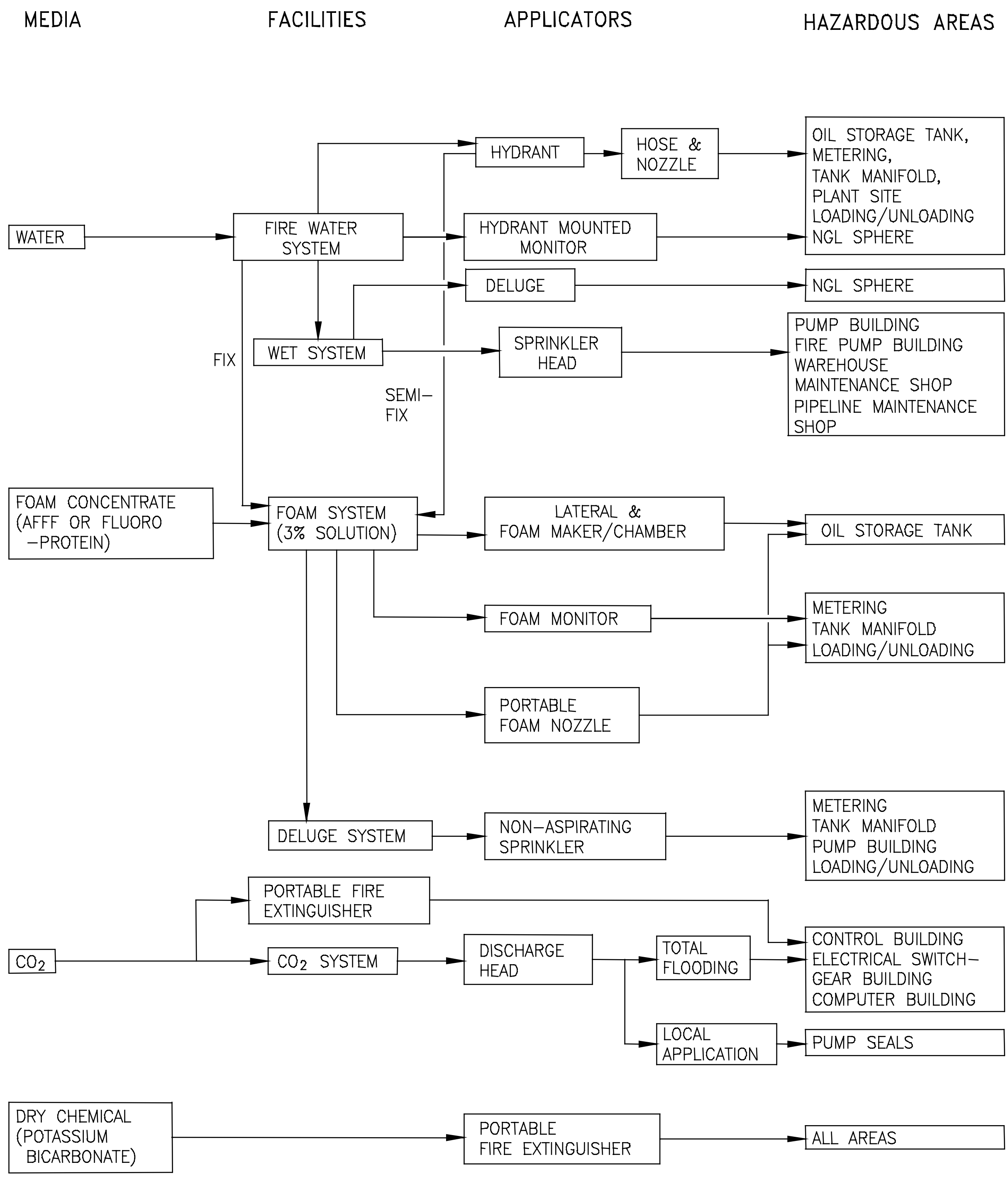


Figure 6.1
Fire Extinguishing Systems and Applications

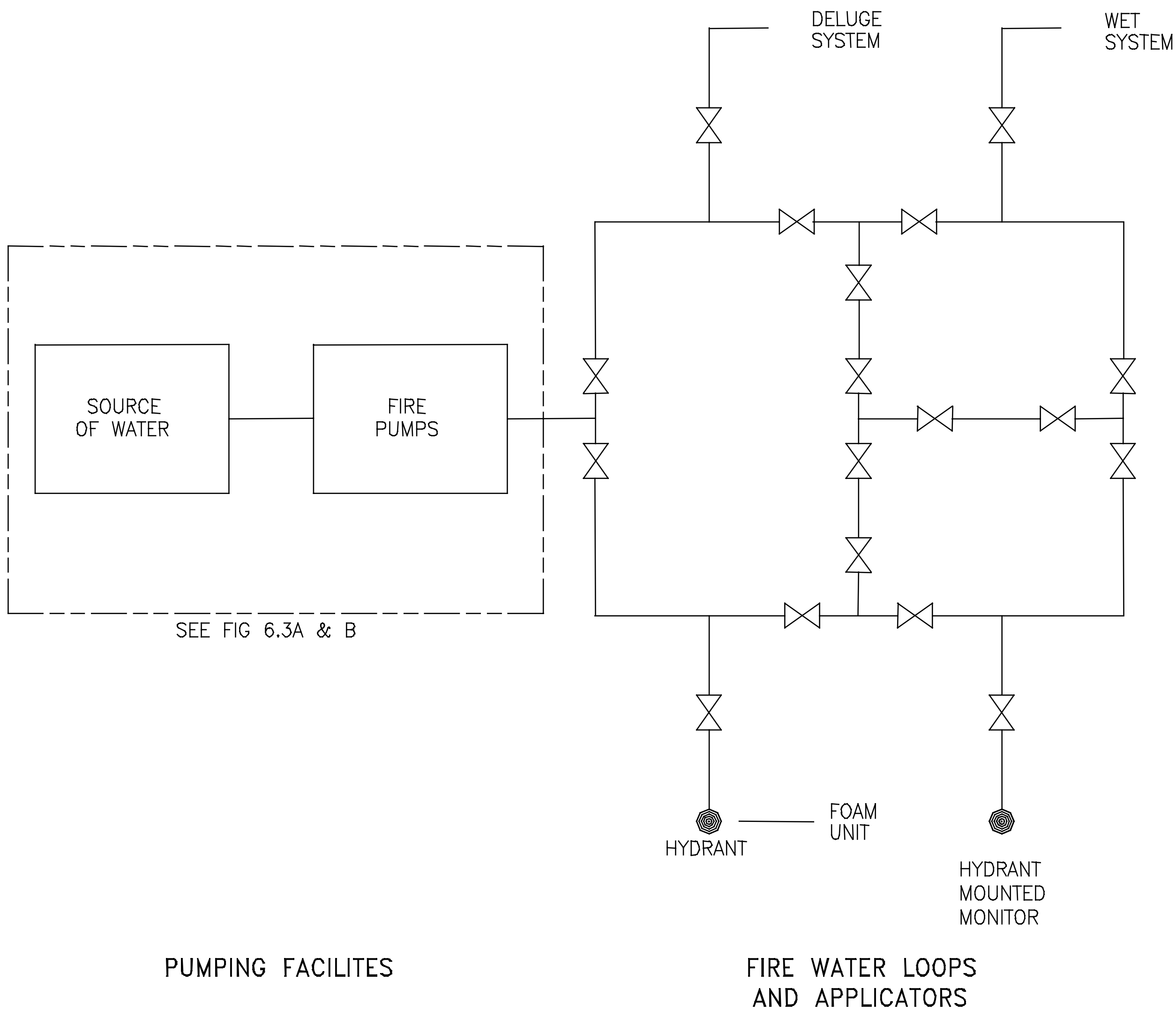

DELUGE SYSTEM
WET SYSTEM
SOURCE OF WATER
FIRE PUMPS
SEE FIG 6.3A & B
HYDRANT
FOAM UNIT
HYDRANT MOUNTED MONITOR
PUMPING FACILITES
FIRE WATER LOOPS AND APPLICATORS

Figure 6.2

Schematic of a Firewater System

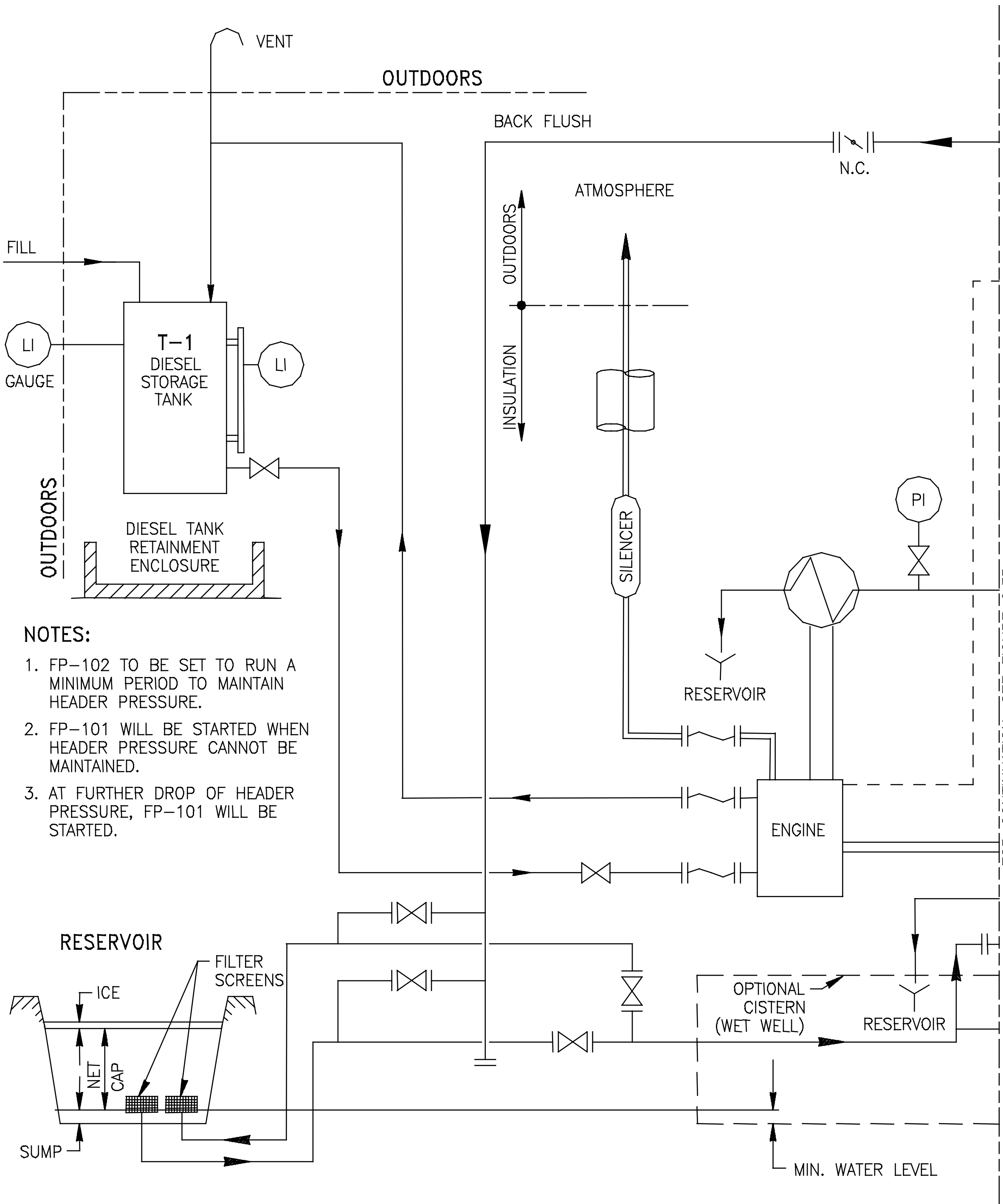


Figure 6.3A

Typical P&ID of a Firewater System

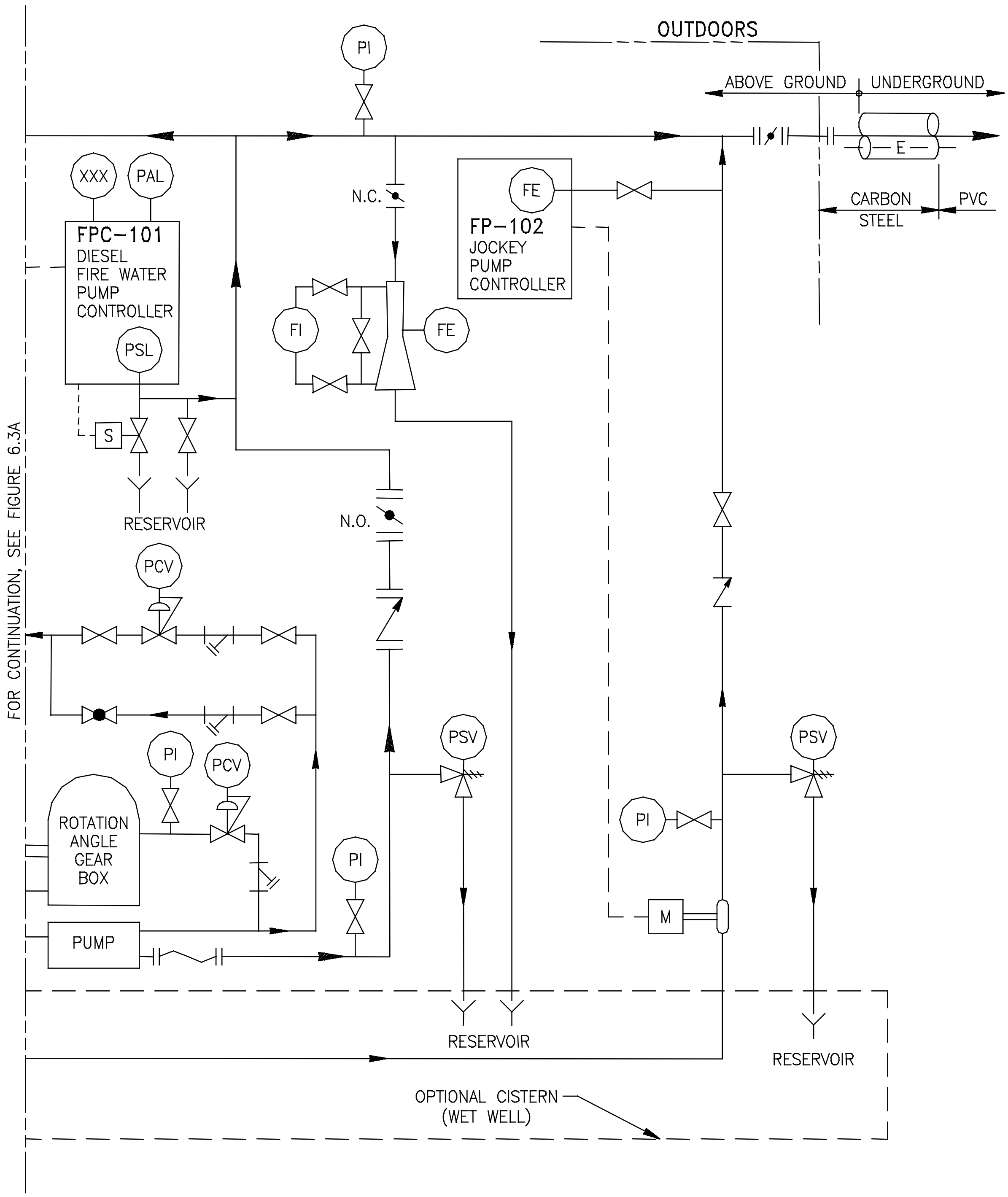
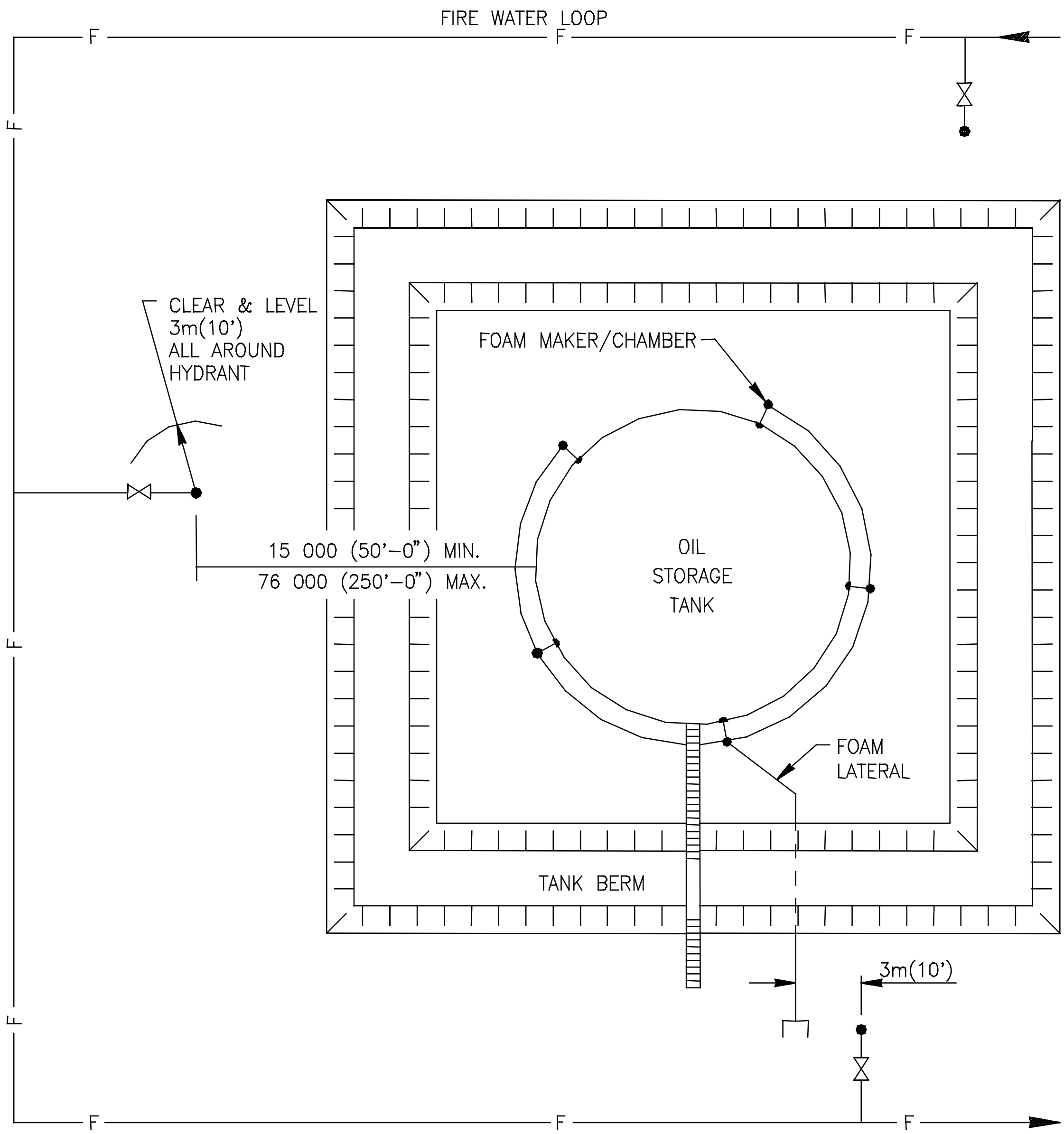


Figure 6.3B

Typical P&ID of a Firewater System

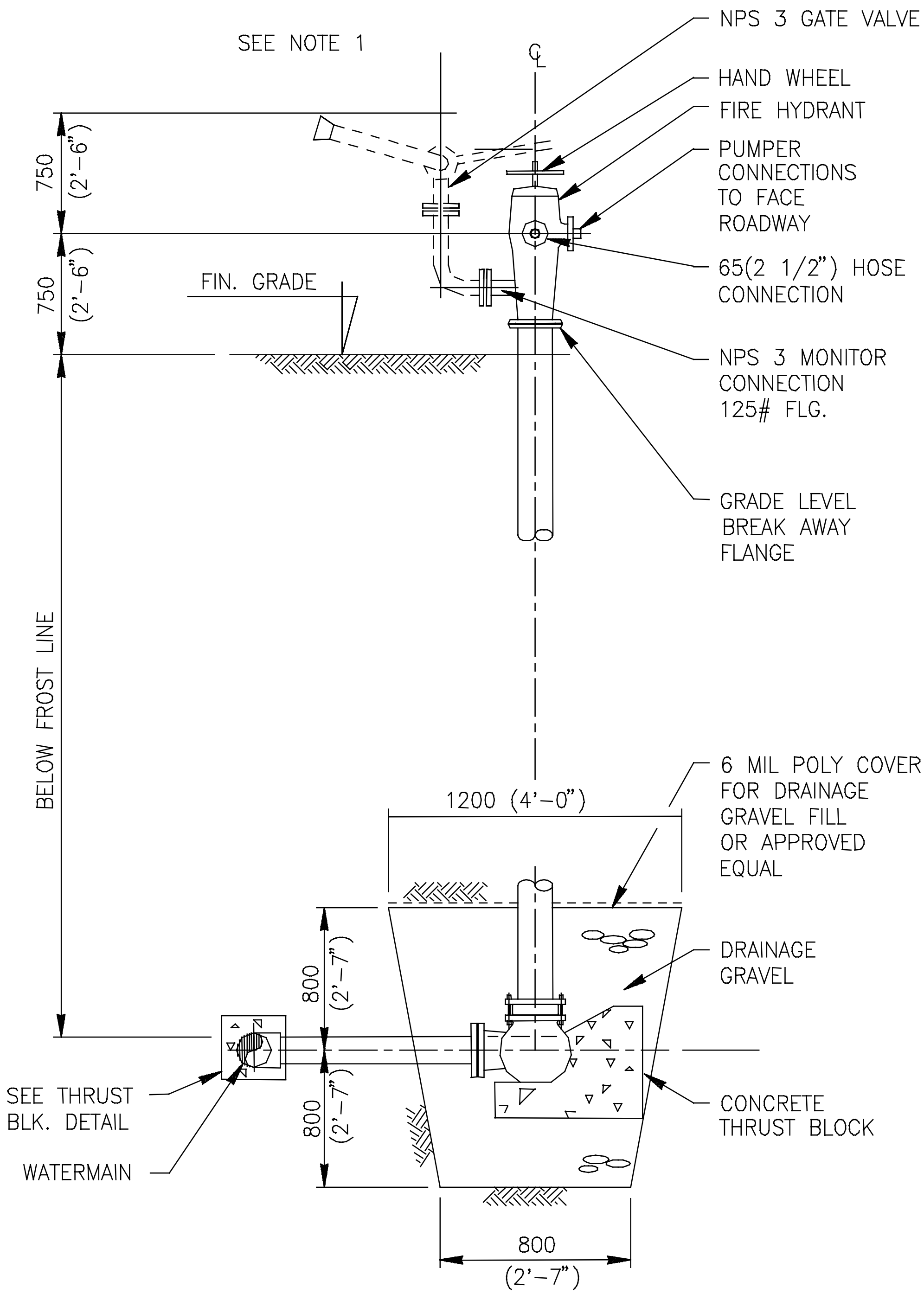


NOTES:

1. MINIMUM 3 HYDRANTS TO BE WITHIN 15 000(50'–0") TO 76 000(250"–0") OF TANK PERIMETER.
2. FOAM CONNECTION OF SEMI–FIXED SYSTEM TO BE LOCATED OUTSIDE TANK DYKE, UPWIND AND WITHIN 3000(10'–0") OF HYDRANT.
3. SPACING OF FOAM MAKER/CHAMBERS FOR 600 (2'–0") HEIGHT FOAM DAM SHALL NOT EXCEED A MAXIMUM SPACING OF 24 400 (80'–0").

Figure 6.4

Fire Protection of Oil Storage Tank

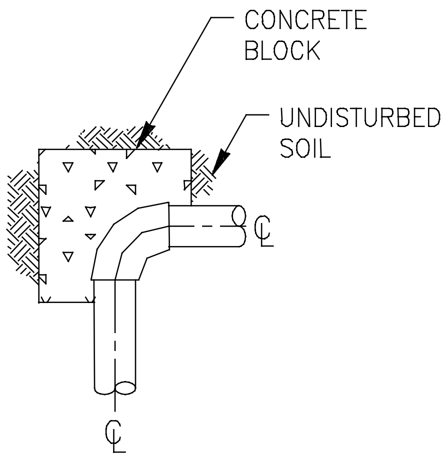


NOTE:

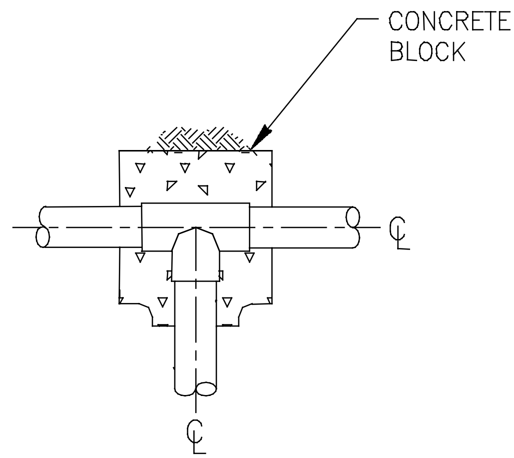
1. HYDRANT MOUNTED MONITOR

Figure 6.5

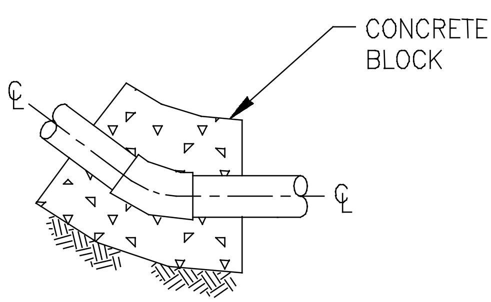
Hydrant Detail



90° BEND PLAN



TEE PLAN



CHANGE OF DIRECTION PLAN

NOTES:

1. PVC FITTINGS, IN CONTACT WITH CONCRETE, SHALL BE WRAPPED WITH A LAYER OF BITUMENIZED PAPER OR POLYETHELENE FILM TO A THICKNESS OF APPROX. 2.54(0.1").
2. CENTRE LINE OF PIPES SHALL ALSO BE THE CENTER LINE OF THE THRUST BLOCKS.
3. THRUST BLOCKS SHALL BE DESIGNED BASED ON SOIL CONDITION USING MINIMUM 25 MPa (3600 psi) CONCRETE TYPICAL.

Figure 6.6

Thrust Block Detail

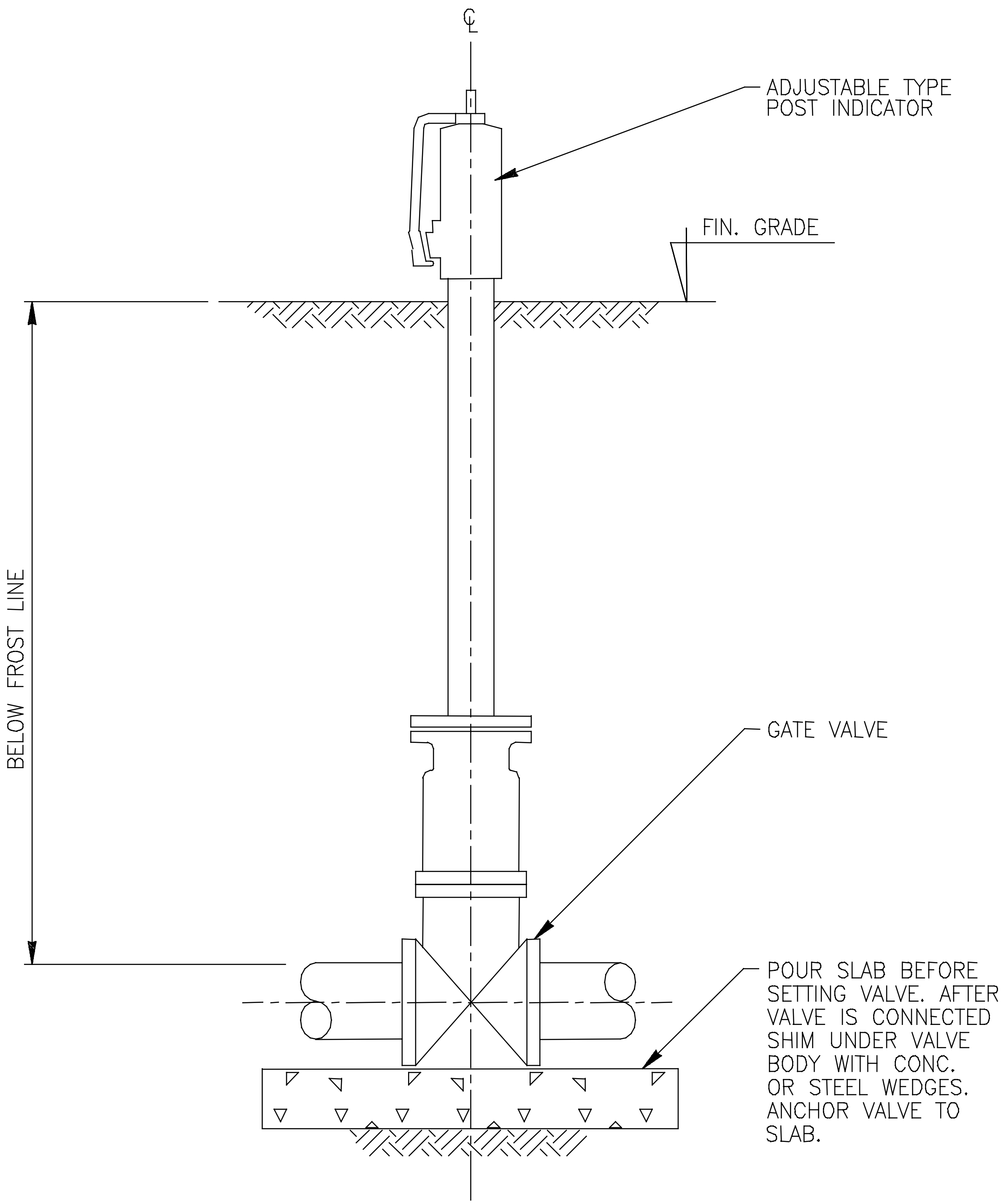


Figure 6.7

Post Indicator Valve Detail

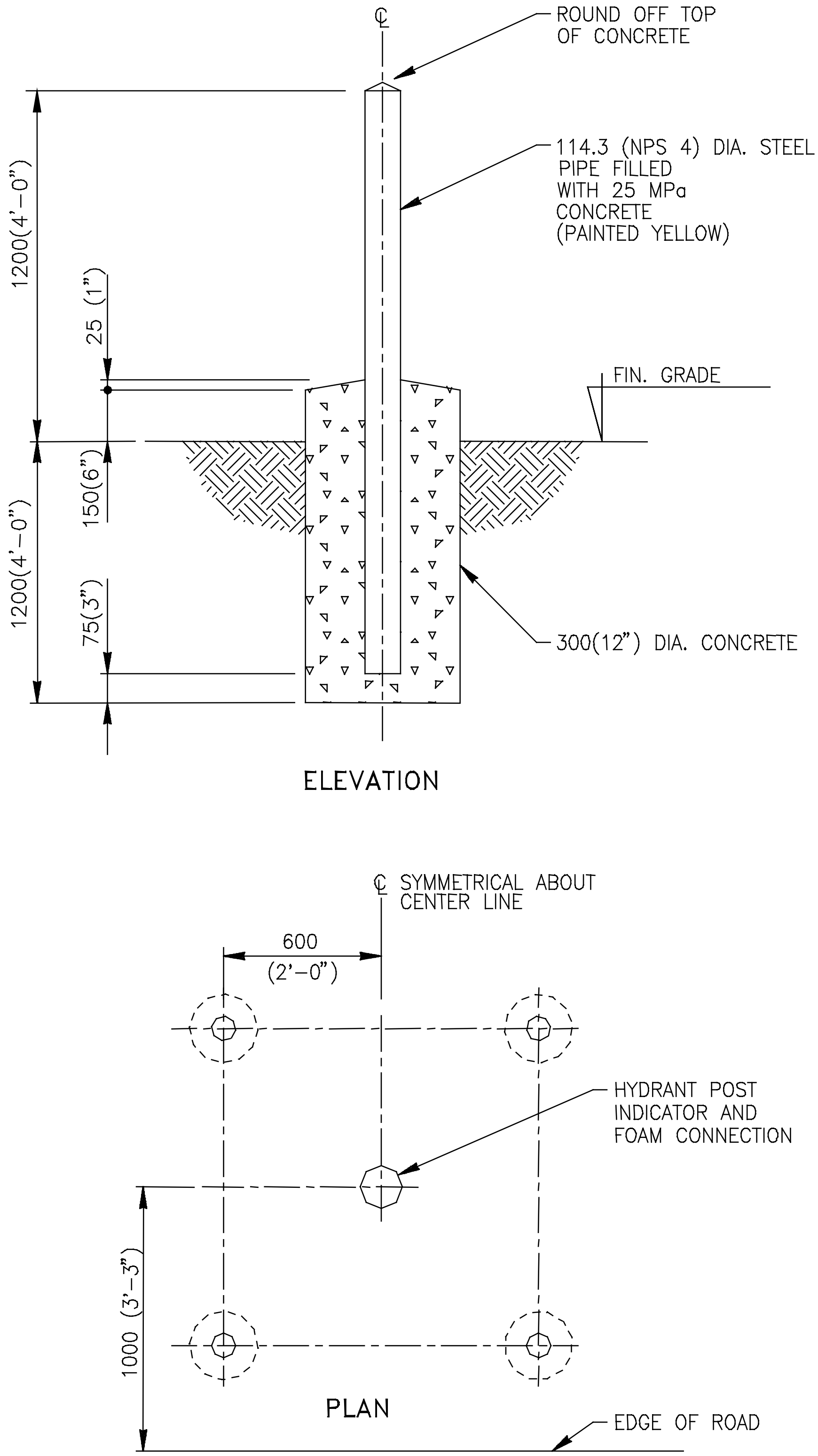


Figure 6.8

Guard Post Detail

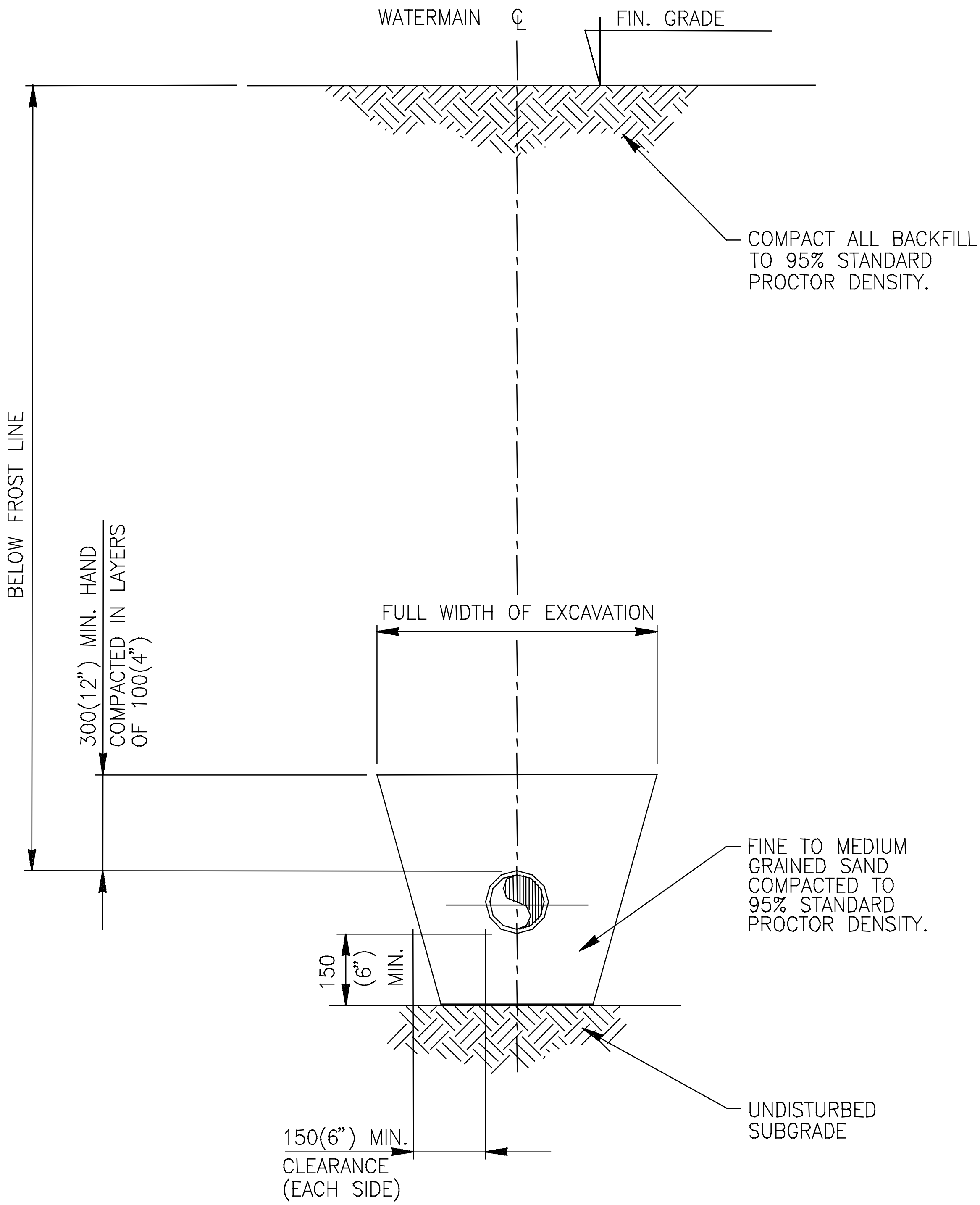
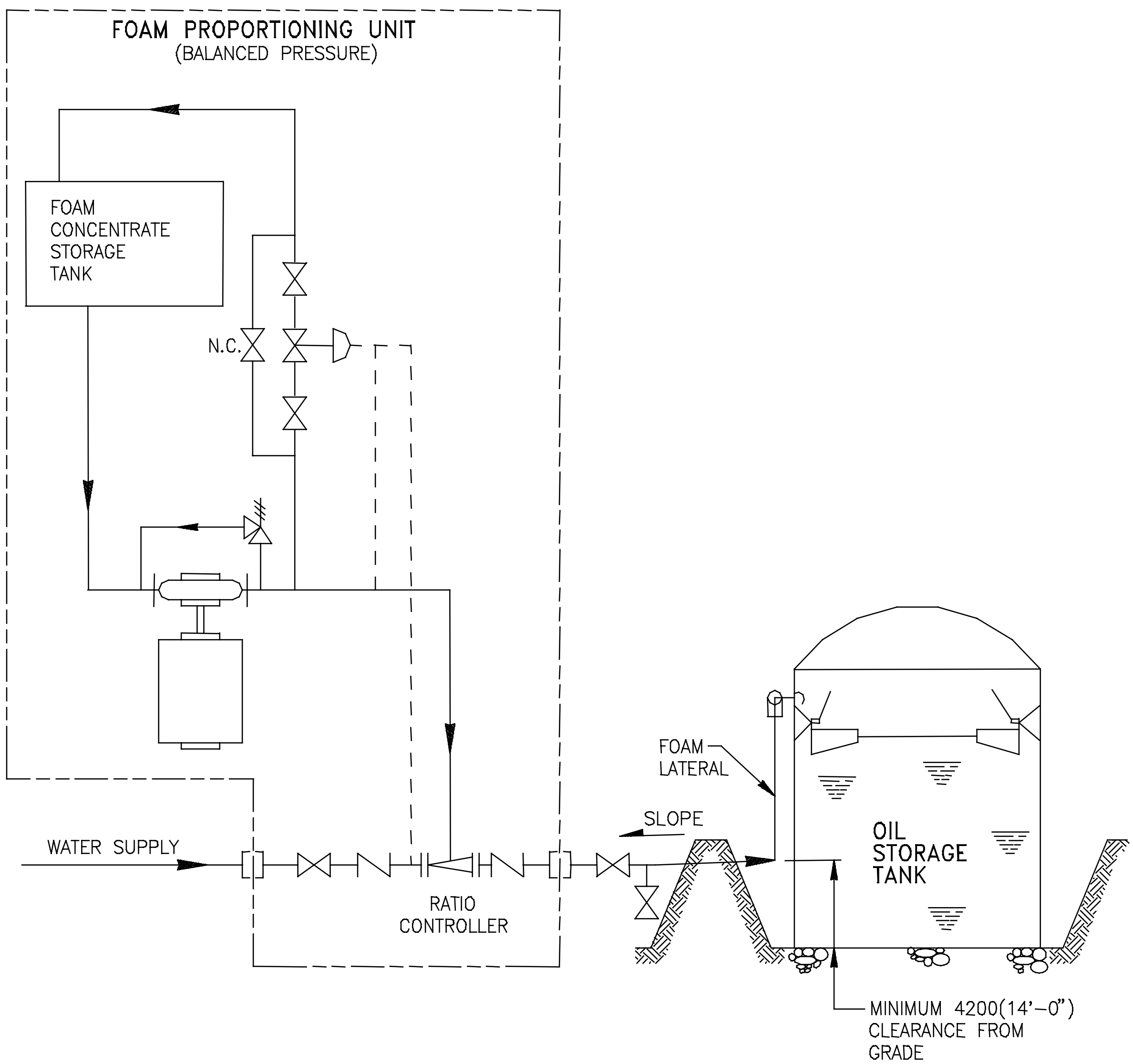


Figure 6.9

Typical Water Main Detail

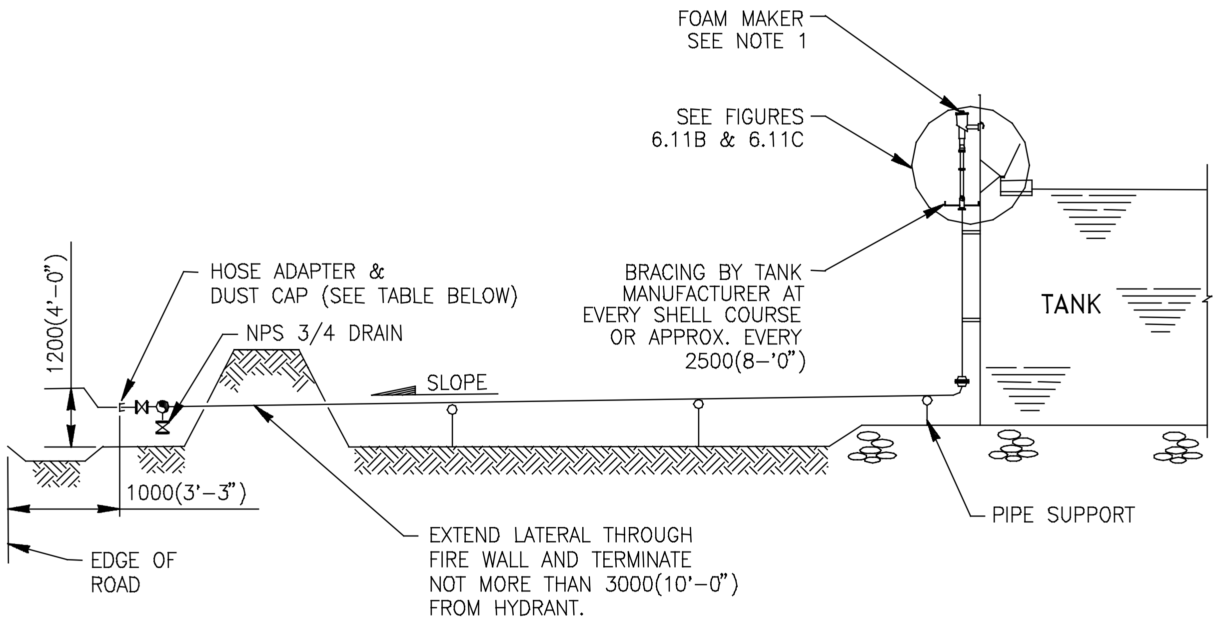


NOTES:

1. FOR SEMI–FIXED SYSTEM, THE FOAM UNIT WILL EITHER BE MOUNTED ON TRAILER OR TRUCK. THE PUMP WILL BE DIESEL ENGINE–DRIVEN. THE SOURCE OF WATER WILL BE FROM HYDRANT.
2. FOR FIXED SYSTEM, PERMANENT PIPING WILL BE INSTALLED AND WEATHER PROTECTED (FROM FOAM UNIT TO FOAM LATERAL).

Figure 6.10

Foam System Schematic



SECTION

LATERALS SHALL TERMINATE AS FOLLOWS:

NO. OF NPS 2 1/2 MATING HOSE COUPLINGS	SYSTEM CAPACITY
2	2850 L/min (750 USGPM)
3	3800 L/min (1000 USGPM)
4	4750 L/min (1250 USGPM)

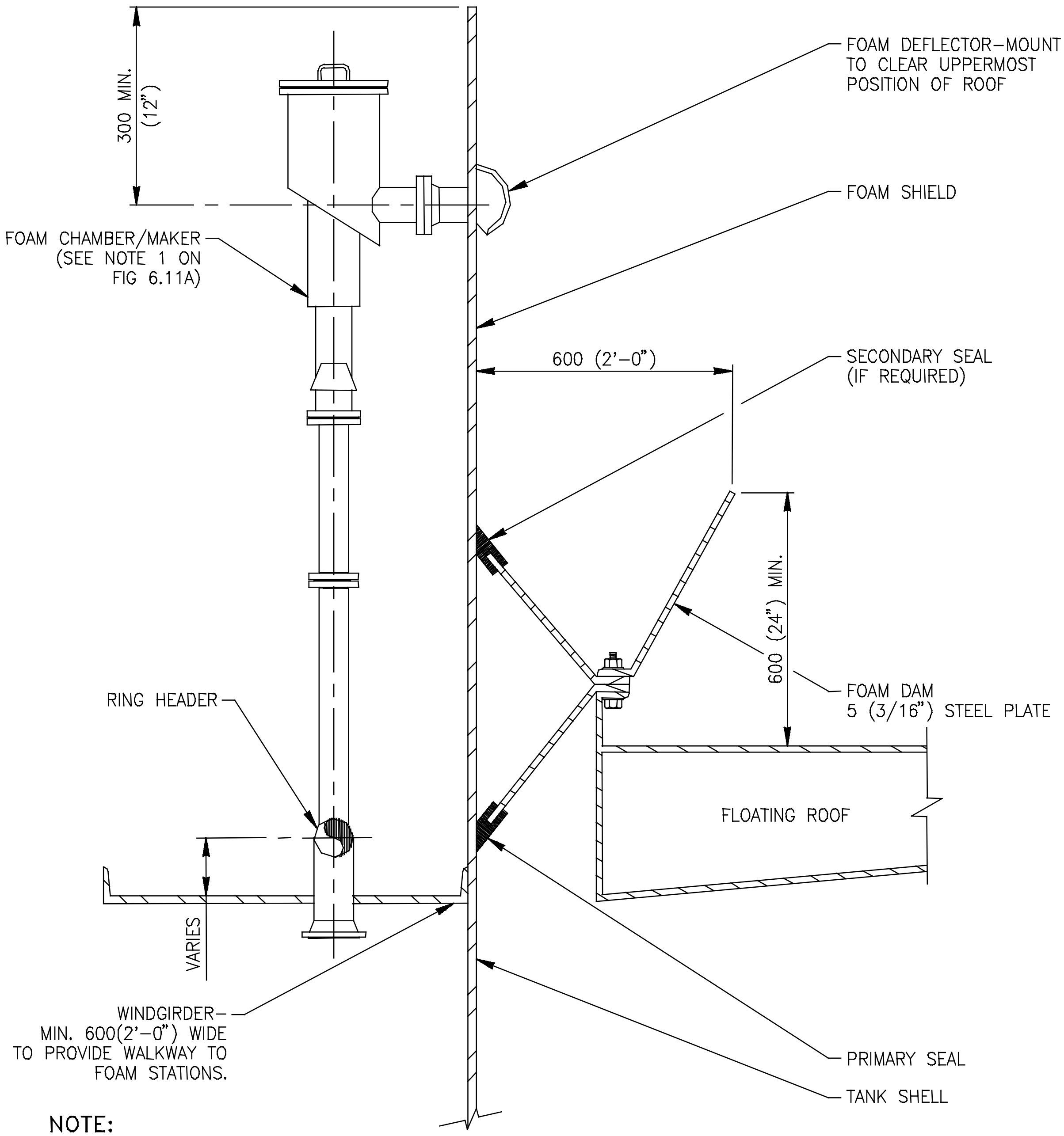
NPS 2 1/2 HOSE COUPLING WITH DUST CAP COUPLING THREADS.

NOTES:

1. FOAM CHAMBER/MAKERS SHALL BE NATIONAL FOAM SYSTEMS, INC. TYPE MBS/MCS-9FR OR EQUIVALENT.
2. SIZE FOAM SYSTEM TO DELIVER FOAM SOLUTION AT 12.3 $L/min/m^2$ (0.3 USGPM PER ft^2) TO FILL AREA BETWEEN THE FOAM DAM AND TANK SHELL.
3. LATERALS SHALL NOT RUN THROUGH THE DYKE AREA OF ANY OTHER TANK OR GROUP OF TANKS.
4. LATERALS SHALL EXTEND OUTSIDE THE DYKE TO POINTS MINIMUM 15 200 (49'–10") FROM SHELL OF TANK.
5. THE DETAILS SHOWN IN FIG. 6.11A,B & C ARE TYPICAL FOR OPEN TOP TANKS HAVING PONTOON TYPE FLOATING ROOFS WITH A 600(2'–0") FOAM DAM. THE DETAILS WILL DIFFER IF TANK ROOF DESIGN IS OF ANOTHER TYPE OR CONFIGURATION.

Figure 6.11A

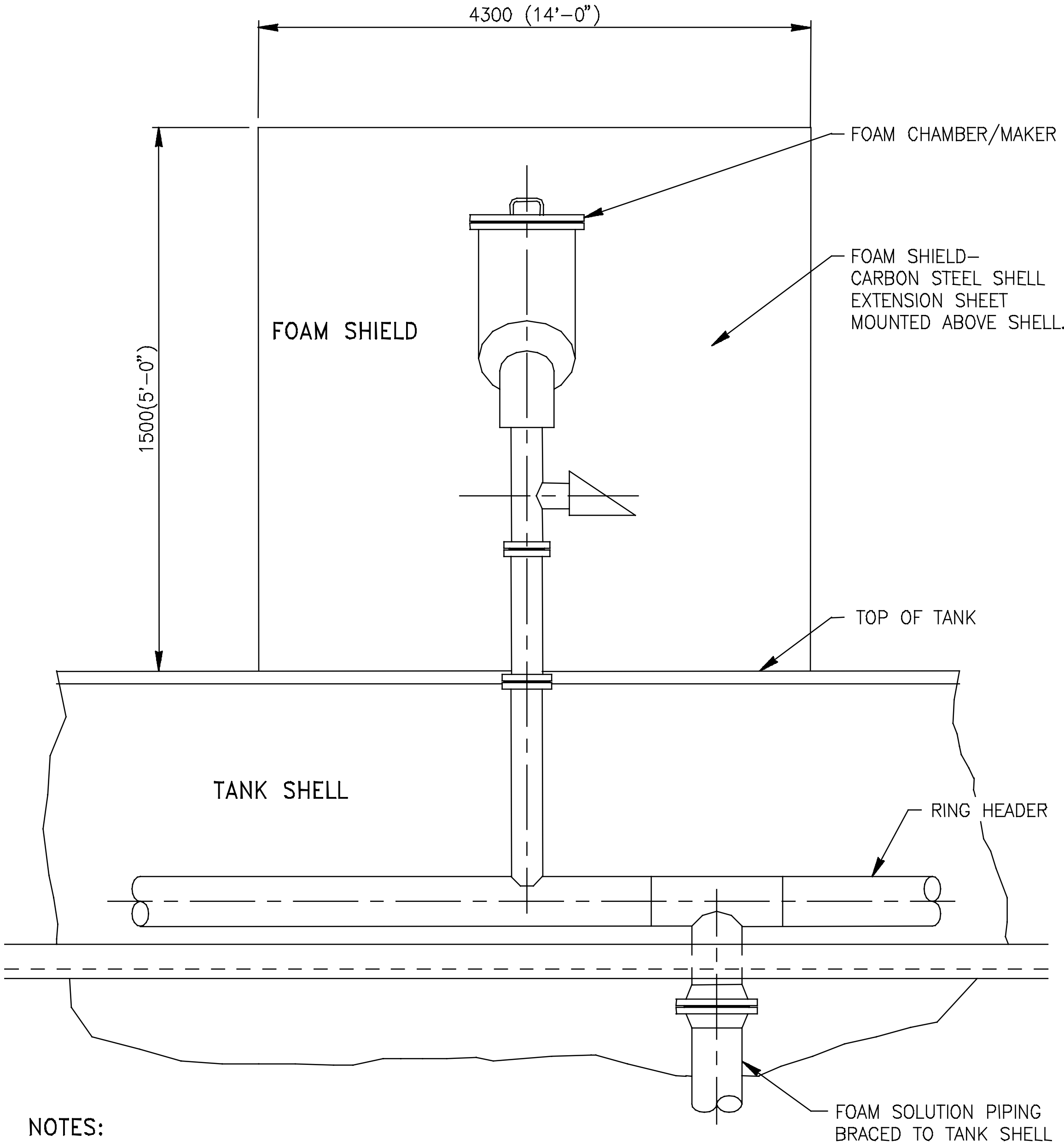
Foam Lateral Layout — Typical



NOTE:
1. REFER TO NOTES IN FIG. 6.11A

Figure 6.11B

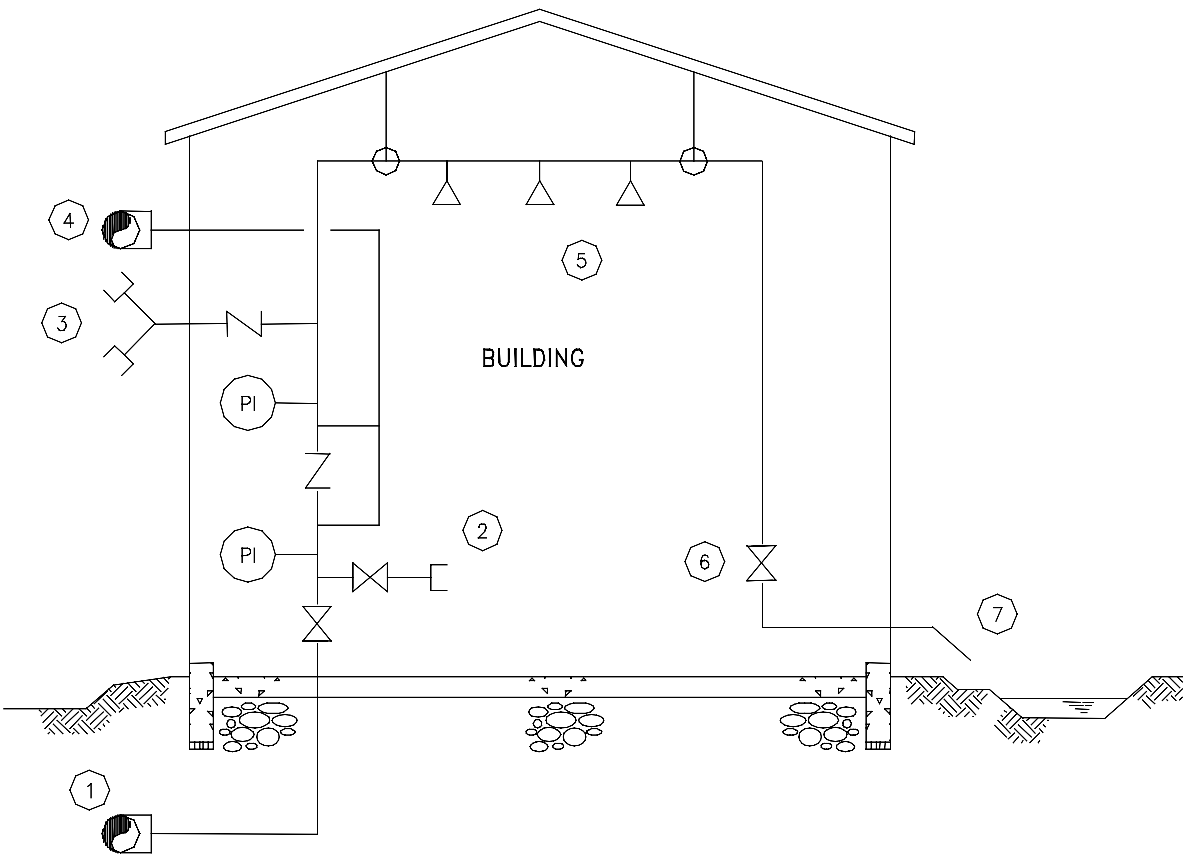
Foam Lateral Detail — Section



NOTES:
1. REFER TO NOTES IN FIG. 6.11A.
2. OPEN TOP EXTERNAL PONTOON FLOATING ROOF AS SHOWN. FOAM LATERAL PIPING IS TYPICAL FOR CLOSED TOP INTERNAL PONTOON FLOATING ROOFS.

Figure 6.11C

Foam Lateral Detail — Elevation



LEGEND

1. UNDERGROUND FIRE WATER MAIN
2. HOSE CONNECTION
3. FIRE DEPARTMENT CONNECTION
4. WATER MOTOR ALARM
5. SPRINKLER HEAD
6. TEST VALUE
7. DRAIN

Figure 6.12

Wet System

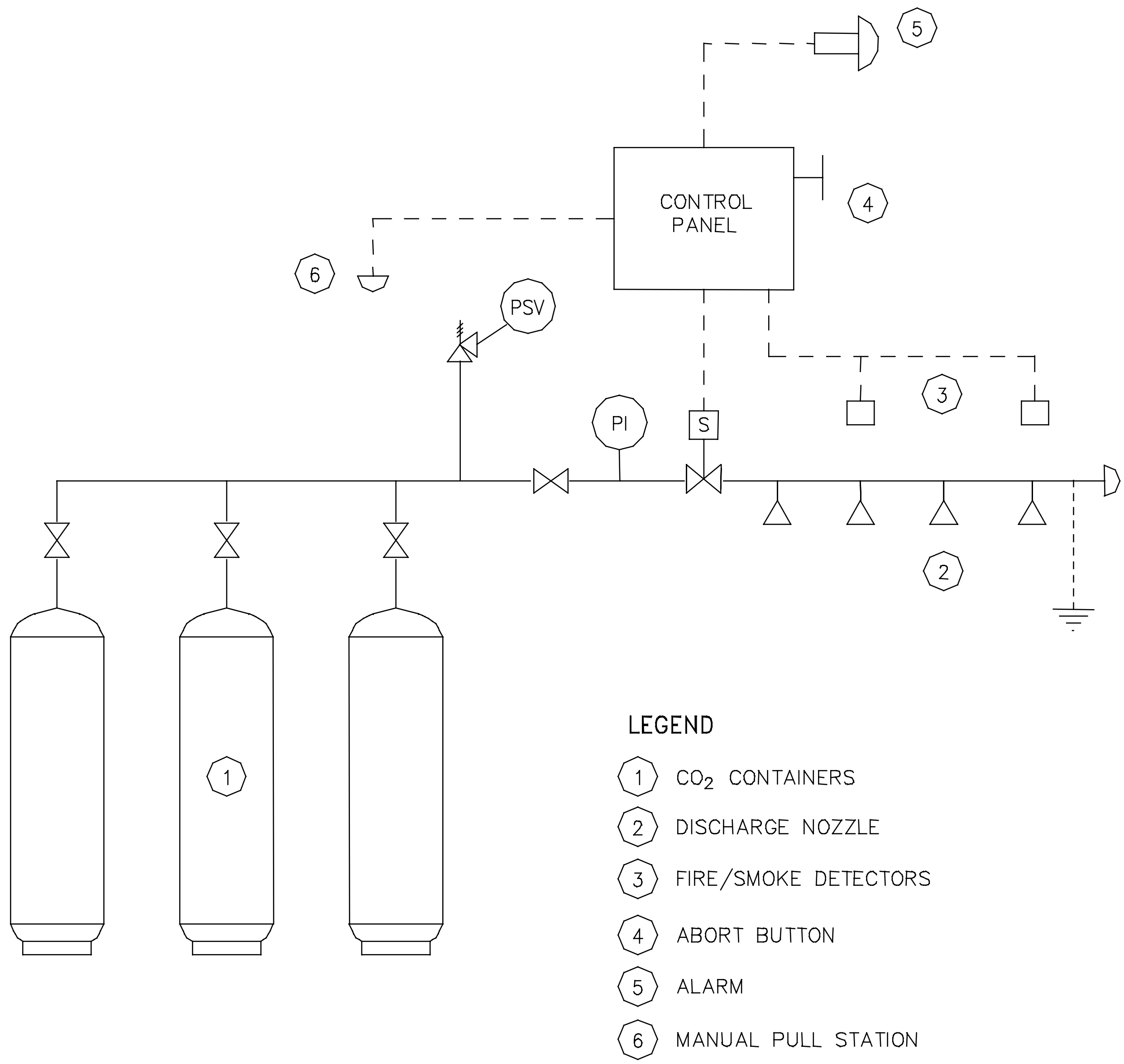


Figure 6.13

7. REVISIONS/EXCEPTIONS

Clause 2.3 Industry Standards

To reflect an update made by the National Fire Protection Association (04/93).

To reflect an update made by the National Fire Protection Association (01/94).

To reflect an update made by the National Fire Protection Association (11/94).

Clause 4.2.3 Pumping Facilities
j. Piping Components

Revised to specify the NDE inspection of fire water system piping.

APPENDIX A – RECOMMENDED PIPING AND ACCESSORIES FOR ABOVE GROUND FIREWATER SERVICE

Item	Material	Size	Description
1	Pipe	½ in. through 2 in.	SMLS carbon steel, ASTM A106, Sch. 80, Galv.
		3 in. through 12 In.	SMLS carbon steel, ASTM A106, standard weight
2	Fittings	½ in. through 2 in.	3000 lb. threaded, ASTM A105M galv.
		3 in. through 12 in.	SMLS carbon steel, ASTM A234M WPB, standard weight, welded fitting
3	Flanges (Note 1)	½ in. through 2 in.	150 lb. RF (FF) SCRD steel, Sch. 80, ASTM A105M, galv.
		3 in. through 12 in.	150 lb. RFWN (FFWN) steel, ASTM A105M, steel weight.
		16 in.	150 lb. RFSO (FFSO) steel, ASTM A105M, steel weight.
4	Pipe Nipple	½ in. through 2 in.	Sch. 160, steel, ASTM A106, TBE, galv.
5	Gaskets	½ in. through 12 in.	Spiral wound T304 SS Grafoil filled, with ⅛ in. centering ring, Flexitallic style “GC” (API Std 601) for raised face flanges.
			Compressed Grafoil, SS wire reinforced, 1/6 in. thick, ANSI B16.21, full face gasket for flat face flanges.
6	Bolting		ASTM A307, Gr. B heavy hex galv. machine bolts with heavy hex galv. nuts
7	Thread Lubricant		Texaco 2303 Thread Tex.
8	Joint Compound		Grinnell pipe joint compound or Permatex 2.
9	Tubing	⅛ in. through ⅜ in.	SMLS copper 0.32 wall PE coated
		½ in. through 1 in.	SMLS copper .032 wall PE coated
10	Tube Fittings	⅜ in. through 1 in.	Male tube conn. brass TXMPT.
		⅜ in. through 1 in.	Female tube conn. brass TXFPT.
		⅜ in. through 1 in.	Tee all tube brass TXTXT.
		⅜ in. through 1 in.	Tubing union all tube brass.
		⅜ in. through 1 in.	Tubing union reducing brass TXT.
		⅜ in. through 1 in.	Coupling with stop solder joint.

11	Gate Valve	¼ in. through 2 in.	200 lb. SCRD single wedge gate valve, all bronze, OS&Y, union bonnet, UL or ULC listed or FM approved.
		3 in. through 12 in.	125 lb. flanged, single wedge gate valve, iron body, bronze mounted, OS&Y, UL or ULC listed or FM approved.
12	Gate Valve (for diesel fuel)	½ in. through 1½ in.	800 lb. threaded gate valve, forged steel, OS&Y, 13 per cent chrome trim, bolted bonnet.
13	Butterfly Valve	6 in. through 12 in.	125 lb. butterfly valve, wafer body, complete with handwheel operator, iron body, position indicator, bronze trim, UL or ULC listed or FM approved Muller wafer 8 butterfly valve or approved equal.
14	Check Valve	½ in. through 2 in.	200 lb. SCRD, horizontal swing check valve, all bronze, SCRD cap.
			125 lb. check valve, wafer body, suitable for vertical and horizontal installation, iron body, bronze clapper and seat, SS spring and hinge pin, resilient seat, UL or ULC listed or FM approved Muller wafer check valve, Style A-2102 or approved equal.

Notes: 1) Use flat face flanges only if equipment/valve connections are flat face, otherwise raised face flanges shall be used.

2) All galvanizing shall be “hot-dip”. Plating is not acceptable.

APPENDIX B — RECOMMENDED PIPING AND ACCESSORIES FOR UNDERGROUND FIREWATER SERVICE

Item	Material	Size	Description
1	Hydrant (without monitor)		Designed in accordance with AWWA C502 compression type closing with water pressure, UL or ULC listed or FM approved. Connections and accessories: — one pumper truck connection; — two 2½ in. hose connections; — base to be 6 in. push-on joint ends for ANSI/AWWA C900 PVC pipe (cast iron O.D.) — all connections shall be with cap and chain; — automatic drain type; and — 15 in. handwheel Canada Valve Century type fire hydrant or approved equal.
2	Hydrant (with monitor)		Designed in accordance with AWWA C502, compression type closing with water pressure, UL or ULC listed or FM approved. Darling Model B-50-BM, or approved equal, complete with: — connections in accordance with Item I; — one 3 in. x 125 lb. ANSI B16.1 flanged monitor connection; — one 3 in. x 125 lb. flanged gate valve, UL or ULC listed or FM approved OS&Y, complete with handwheel; and — one 3 in. UL or ULC listed or FM approved 125 lb. ASA FF flanged monitor assembly.
3	Post Indicator Gate Valve	6 in. through 12 in.	Class 150, push-on joint ends for ANSI/AWWA C900 PVC pipe (cast iron O.D.), gate valve iron body, double revolving disk, parallel seat, bronze mounted, nonrising stem, complete with post indicator flange and post indicator assembly conforming to AWWA standards. Both valve and post indicator shall be FM, UL, ULC approved. Darling or approved equal.

4	PVC Piping	6 in. through 12 in.	PVC pipe conforming to ANSI/AWWA C900, certified to CAN/CSA-B137.3 standard for pressure piping, UL or ULC listed or FM approved. Class 150, cast iron equivalent O.D. with integral bells. Joint design to be bell and spigot with gasket seal to ASTM D3139. Scepter Centurion ANSI/AWWA C900 PVC piping or approved equal.
5	PVC Fitting	6 in. through 12 in.	PVC piping fittings, conforming to ANSI/AWWA C900 certified to CAN/CSA-B137.3, Class 150, with cast iron O.D. Joint design to be bell and spigot with gasket seal, PVC compound meeting or exceeding requirement of all classification 12454-B (ASTM D1784), UL or ULC listed or FM approved. Scepter Centurion PVC fitting or approved equal.
6	Carbon Steel Piping	6 in. to 12 in.	SMLS, steel, A106B, Sch. 40, coated and wrapped externally with yellow jacket in accordance with Shaw Pipe Protection Spec YJ No. 1, latest revision.
7	Carbon Steel Fitting	6 in. through 12 in.	Carbon steel welded fitting, ASTM A234M WPB, steel weight, externally coated in accordance with Item 6.
8	Gaskets	6 in. through 12 in.	Spiral wound T304 SS Grafoil, filled with ⅛ in. centering ring, Flexitallic Style “CG” (API Std 601) for raised face flanges. Compressed Grafoil, SS wire reinforced, full face gasket, 1/16 in. thick, ANSI B16.21, for flat face flanges.
9	Bolting		ASTM A307, Gr. B, heavy hex galv., machine bolts with heavy hex galv. nuts.
10	Coupling (PVC to CS)		Robar 1400 series couplings, cast iron material with 304 SS fasteners.

Notes: 1) All exposed steel, including flanges and bolting, shall be coated and wrapped for underground service.