Engineering Standard

SAES-B-017 15 March 2006

Fire Water System Design

Saudi Aramco DeskTop Standards

Table of Contents

Primary contact: Ashoor, Esam Ahmed on 966-3-8728431

1 Scope

This Standard defines the minimum mandatory requirements governing the design and installation of fire water systems.

Exceptions:

a) Where this Standard is in conflict with specialized requirements for offshore platforms, covered in SAES-B-009; for piers, wharves, sea islands, in SAES-B-060; and bulk plants/air fueling operations, in SAES-B-070, those Standards shall govern.

b) Fire water systems are not required at wellsites.

c) The requirements of this Standard do not apply to company gas stations.

2 Conflicts and Deviations

2.1 Any conflicts between this Standard and other applicable Saudi Aramco Engineering Standards (SAESs), Saudi Aramco Materials System Specifications (SAMSSs), Saudi Aramco Standard Drawings (SASDs), or industry standards, codes, and forms shall be resolved in writing by the Company or Buyer Representative through the Manager, Loss Prevention Department of Saudi Aramco, Dhahran.

2.2 Direct all requests to deviate from the Standard in writing to the Company or Buyer Representative, who shall follow internal company procedure SAEP-302 and forward such requests to the Manager, Loss Prevention Department of Saudi Aramco, Dhahran.

3 References

The selection of material and equipment and the design, construction, maintenance, and repair of equipment and facilities covered by this Standard shall comply with the latest edition of referenced Specifications, Standards, Codes, Forms, Drawings, and similar material (including all revisions, addenda, and supplements) unless stated otherwise.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedure

SAEP-302	*Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement*

Saudi Aramco Engineering Standards

SAES-A-004	*Pressure Testing*
SAES-B-005	*Spacing and Diking for Atmospheric and Low-Pressure Tanks*
SAES-B-006	*Fireproofing in Onshore Facilities*
SAES-B-008	*Restrictions to Use of Cellars, Pits, and Trenches*
SAES-B-009	*Fire Protection and Safety Requirements for Offshore Production Facilities*
SAES-B-014	*Safety Requirements for Plant and Operations Support Buildings*
SAES-B-018	*Air Foam Systems for Storage Tanks*
SAES-B-019	*Portable Firefighting Equipment*
SAES-B-054	*Access, Egress, and Materials Handling for Plant Facilities*
SAES-B-055	*Plant Layout*
SAES-B-057	*Safety Requirements: Refrigerated and Pressure Storage Vessels*
SAES-B-060	*Fire Protection for Piers, Wharves, and Sea Islands*
SAES-B-070	*Bulk Plants and Air Fueling Operations*
SAES-D-100	*Design Criteria of Atmospheric and Low-pressure Tanks*
SAES-G-005	*Centrifugal Pumps*
SAES-H-002	*Internal and External Coatings for Steel Pipelines and Piping*
SAES-J-604	*Protective and Condition Monitoring Equipment for Rotating Machinery*
SAES-L-005	*Limitations on Piping Components*
SAES-L-006	*Metallic Pipe Selection*
SAES-L-007	*Selection of Metallic Pipe Fittings*
SAES-L-008	*Selection of Valves*
SAES-L-009	*Metallic Flanges, Gaskets and Bolts for Low and Intermediate Temperature Service*

SAES-L-010	*Limitations on Piping Joints*
SAES-L-011	*Flexibility, Support and Anchoring of Piping*
SAES-L-032	*Materials Selection for Piping Systems*
SAES-L-033	*Corrosion Protection Requirements for Pipelines/Piping*
SAES-L-041	*Utility Piping Connections to Process Equipment*
SAES-L-046	*Pipeline Crossings Under Roads and Railroads*
SAES-L-050	*Construction Requirements for Metallic Plant Piping*
SAES-M-100	*Saudi Aramco Building Code*
SAES-P-114	*Power System and Equipment Protection*
SAES-P-116	*Switchgear and Control Equipment*
SAES-S-020	*Industrial Drainage and Sewers*
SAES-S-040	*Saudi Aramco Water Systems*
SAES-S-050	*Sprinkler and Standpipe System Components in Buildings*
SAES-S-070	*Installation of Utility Piping Systems*
SAES-X-600	*Cathodic Protection of Plant Facilities*

Saudi Aramco General Instructions

GI-0002.102	*Pressure Testing Safely*
GI-0006.012	*Isolation, Lockout, and Use of Hold Tags*
GI-1781.001	*Inspection, Testing and Maintenance of Fire Protection Equipment*
GI-1782.001	*Inspection, Inspection and Maintenance of Fixed Fire Protection Systems*

Saudi Aramco Standard Drawings

AD-36010	*Wellhead Guard Posts, Plan and Details*
AD-036090	*Joints for Welding Cement Lined Pipe*
AB-036381	*Cathodic Protection Thermite Welding of Cables to Pipelines and Structures*
AA-036629	*Cathodic Protection of Hydrants and Risers from (RTR) Mains*

AE-036768	*External Welding Sleeves for Cement Lined Pipe*

Saudi Aramco Library Drawing

DB-950078	*Concrete Thrust Block Details for Utility Pipelines*

Saudi Aramco Engineering Reports

SAER-5248	*Saudi Aramco Water Terminology*
SAER-5558	*Susceptibility of Losing Electrical Substations Due to Transformer Fires*

3.2 Industry Codes and Standards

International Fire Code Institute

UFC	*Uniform Fire Code - 1994 Edition*

National Fire Protection Association

NFPA 13	*Installation of Sprinkler Systems*
NFPA 15	*Water Spray Fixed Systems for Fire Protection*
NFPA 20	*Centrifugal Fire Pumps*
NFPA 24	*Installation of Private Fire Service Mains and Their Appurtenances*
NFPA 25	*Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*
NFPA 214	*Water-Cooling Towers*
NFPA 231	*General Storage*
NFPA 231C	*Rack Storage of Materials*
NFPA 1963	*Fire Hose Connections*

4 Definitions

Capacity Design Basis of a Fire Water System: That flow rate which is needed to supply the highest calculated fire water demand risk area served by the system. See Section 5.7.

Combustible Gas: Any gas that can form an ignitable mixture with air.

Combustible Liquid: A liquid that has a flash point greater than 54°C (130°F).

Fire Water System: A fire water system is a piping system for distributing fire water to Saudi Aramco facilities within the scope of this Standard. It includes a supply source, storage, pump suction piping, fire water pumps, jockey pumps, discharge piping, fire water distribution piping, branch piping, associated fixed fire protection equipment, valves, and fittings.

Flammable Liquid: A liquid that has a flash point equal to or less than 54°C (130°F).

Residual Pressure: Pressure of water at a specific flowing condition. Requirements for the minimum residual pressure are given in Section 5.8.

Risk Area: A hypothetical fire protection area in a process facility. It is used for the purposes of sizing fire water systems and to prevent spread of fire from one area to another. See Section 5. For the purposes of defining process risk areas only, a process risk area facility shall include any facility where hydrocarbons are produced, processed, stored, or loaded, with the exceptions of wellsites and company gas stations. Otherwise, bulk plants and fuel terminals are considered nonprocess areas and have some specialized requirements, as treated in Section 13 and in SAES-B-070.

RTR Pipe: Glass-fiber-reinforced thermosetting resin pipe, also called RTRP or fiberglass pipe.

5 General System Design

This section deals with general design requirements of fire water systems serving process facilities, residential areas, and support facilities. Sections 5.1 through 5.6 cover "process risk areas". The rest of Section 5 is generally applicable to all Saudi Aramco fire water systems.

5.1 Process Areas

All process facilities to be served by a fire water system shall be segregated into risk areas for the purposes of fire water system design. The following applies to process areas with vessels and equipment which contain flammable or combustible liquids or combustible gases:

a. Each shall be a logically defined area that may be described in terms of equipment or buildings.

b. The minimum distance between equipment and vessels in one risk area and equipment, vessels, or drainage swales in other risk areas shall be 15 m (50 ft).

c. There shall be clear fire vehicle access to at least two opposite sides of a risk area. Road width shall be in accordance with SAES-B-055.

d. For the purposes of fire water capacity design calculations, when there is a common pipeway located between two risk areas, and the space between equipment and the pipeway is less than 7.5 m from both risk areas, the pipeway shall be a part of both risk areas. If a pipeway is less than 7.5 m from only one risk area, the pipeway shall be included in only that risk area. Fin-fan coolers shall be considered as pipeways.

5.2 The boundaries of a risk area shall be determined by the outermost equipment, vessels, and any included pipeways, containing process flammable / combustible liquids or combustible gases.

5.3 High-Risk Process Area

5.3.1 A "high-risk process area" is an area where one or more of the following conditions exist:

a. Equipment containing fractionated, liquefied light hydrocarbons (butane or lighter).

b. Equipment processing any of the following substances at autoignition temperature: flammable liquid, combustible liquid, or combustible gas.

c. Equipment processing flammable/combustible liquid or combustible gas at a pressure of 6900 $kPa_{(ga)}$ (1000 psig) or greater.

d. Equipment which is unusually congested or a concentration of equipment of high value.

Commentary Note:

Examples of such high-risk areas are Rheniformers, hydrogen treating plants, NGL fractionation plants and LPG refrigeration plants.

5.3.2 The surface area of a high-risk process area shall not exceed 1860 m^2 (20 000 ft^2) without concurrence of the Chief Fire Prevention Engineer.

5.4 Medium-Risk Process Area

An area shall be designated a "medium-risk process area" when the following are processed or handled:

a. Crude oil or fuel products processed above their flash point.

b. Where flammable (as defined in SAES-B-005) fuel products are processed or where gas treatment facilities are operated.

Commentary Note:

Examples of such medium-risk areas are stabilizers, gas treating plants, asphalt oxidizers, sulfur plants, and onshore GOSPs. See the exception to Section 5.6.2 for stand-alone onshore GOSPs.

5.5 Low-Risk Process Area

An area in which combustible liquids are processed or handled at ambient temperatures shall be designated as a "low-risk process area".

Commentary Note:

An example of a low-risk facility would be a diesel-handling pump station. Boiler and air/water utility areas have also been classified as low-risk facilities, despite the presence of fuel gas piping, as long as gas piping is only for fuel to local boilers.

5.6 Fire Water Demand for Process Risk Areas

5.6.1 For high-risk process areas, the number and capacity of monitors and spray systems required to cover the equipment shall be determined per Sections 9 and 10. The fire water demand shall be computed by summing the design flow rate of each monitor and spray system. The flow rate provided to a high-risk process area shall not be less than 63 L/s (1000 gpm) but is not required to exceed 252 L/s (4000 gpm), including fixed spray requirements.

Commentary Note:

This demand may be initially estimated by computing a rate based upon the area encompassed by the boundaries of the process risk area. A density of 0.14 L/m²s (0.20 gpm/ft²) shall be used. Deluge system demand (primarily for spheres and spheroids, see 11.1) is not included in the 4000 gpm ceiling.

5.6.2 For medium-risk process areas, the demand shall be calculated in a manner similar to that of high-risk process areas, with the following exceptions:

a. The flow rate provided to a medium-risk process area shall not be less than 63 L/s (1000 gpm) but is not required to exceed 190 L/s (3000 gpm), including fixed spray requirements.

b. The density used to initially estimate flow shall be 0.10 L/m²s (0.15 gpm/ft²).

Exception:

For onshore GOSPs and cross-country pipeline pump stations that are stand-alone and not part of other plant facilities, the flow rate is not required to exceed 63 L/s (1000 gpm), plus spheroid deluge requirement if located within the same risk area. Where onshore GOSPs are adjacent to or part of other plant facilities having medium-risk or high-risk process areas, this exception does not apply. Where onshore GOSPs have other process equipment such as topping units or stabilizer columns, the capacity design basis for the fire water system shall be developed with the Chief Fire Prevention Engineer.

Commentary Notes:

The rationale for using a lower fire water design rate for stand-alone GOSPs takes into account the following factors:

a. limited manpower available;

b. limited availability of water at many GOSPs.

c. remoteness from other facilities, greatly reducing the likelihood of fire spreading from the stand-alone GOSP to other facilities.

5.6.3 For low-risk process areas, the demand shall be calculated in a manner similar to that of high-risk process areas, with the following exceptions:

Exceptions:

a. The flow rate provided to a low-risk process area shall not be less than 19 L/s (300 gpm) but is not required to exceed 63 L/s (1000 gpm), including fixed spray requirements.

b. The density used to initially estimate flow shall be 0.07 L/m²s (0.10 gpm/ft²).

5.7 Capacity Design Basis

5.7.1 A fire water system shall be designed to provide the maximum flow rate requirement of any single risk area served by the system. The capacity design basis of the system is set by the risk area having the highest flow rate requirement.

5.7.2 Fire water systems shall be analyzed using computer software specialized for cross loop flow analysis of fire water systems to assure that the system will meet flow-rate and residual pressure requirements at each piece of fire protection equipment.

5.7.3 Pressure-drop calculations shall be based upon Hazen-Williams formulae. The following flow factors (C-factors) shall be used:

Cement-Lined Steel	C = 130
90/10 Cu/Ni	C = 140
Reinforced Thermosetting Resin Pipe	C = 135[1]

[1] C-factors higher than 135 for RTR pipe may be used with approval of the Chief Fire Prevention Engineer.

5.7.4 Prior to introducing hydrocarbons, actual flow-testing of the fire water system shall be done to confirm that the required design flows, residual pressures, and other system tests and checks per NFPA 25 are achieved. The flow test shall be witnessed by the Chief Fire Prevention Engineer and the General Supervisor, P&TS Div., Fire Protection Department or their representatives. Deficiencies shall be corrected prior to final acceptance. A record of the flow test shall be provided to the Chief Fire Prevention Engineer and the General Supervisor, P&TS Div., Fire Protection Department.

5.8 Minimum Residual Pressure

Fire water systems shall be designed to provide the minimum residual pressure at the hydraulically most remote piece of firefighting equipment in each risk area assuming (a) water flow to the firefighting equipment in the risk area meets the requirements of this Standard and (b) the specific piece of firefighting equipment is operating at its required flow. Residual pressure at individual equipment shall not exceed 1140 $kPa_{(ga)}$ (165 psig) without concurrence of the Chief Fire Prevention Engineer.

Minimum Residual Pressure at Design Flow [$kPa_{(ga)}$ (psig)]		
Monitors	700 (100)	
Live Hose Reels	700 (100)	Exception (a)
Hydrants	700 (100)	Exception (b)
Deluge Nozzles	175 (25)	
Spray Nozzles	207 (30)	Exception (c)
Sprinkler Nozzles	140 (20)	

Exceptions:

a. This pressure for hose reels may be reduced to 415 $kPa_{(ga)}$ (60 psig) in support facilities only.

b. For fire hydrants intended to supply water only to mobile firefighting apparatus (primarily in residential areas), the minimum residual pressure shall be 140 $kPa_{(ga)}$ (20 psig). If the hydrant is intended to directly supply fire hose, the minimum residual pressure shall be 550 $kPa_{(ga)}$ (80 psig) for residential areas and 700 $kPa_{(ga)}$ (100 psig) for process facilities (See SAES-B-019, Table 1).

c. This pressure for spray nozzles is to be used as a starting point only. The minimum acceptable pressure shall be that necessary to give desired coverage in specific design situations. Wind losses shall be considered in outdoor designs.

5.9 The fire water to any process risk area shall be distributed through a looped fire water system.

5.10 Dedicated fire water systems shall be provided for onshore hydrocarbon processing and storage facilities; process and utility water shall not be provided through the fire water system. Dedication of water tankage shall be as required in Section 6.

Exception:

For stand-alone GOSPs, bulk plants, cross-country pipeline pump stations, and all offshore facilities, a combined utility and fire water system is allowed.

Commentary Note:

Dedicated fire water systems in existing processing and storage facilities are recommended. Facilities that now have combined utility/fire water systems should be evaluated for isolation capability, and decisions concerning separation of the utility and fire water systems should be documented by the responsible Safe Operations Committee (SOC).

5.11 In facilities subject to freezing temperatures severe enough to affect operation of the fire water systems, freeze protection shall be incorporated in the design.

Commentary Note:

While there is currently no evidence that indicates a freezing problem exists in most areas, expansion facilities in exposed or mountainous areas in the Central or Western regions could be found to require some protection. For example, dry-barrel hydrants may be considered (waiver required) for these areas. Note that fire water systems exposed to slightly freezing air temperatures at night do not necessarily require freeze protection.

5.12 Drainage to remove applied fire water shall meet SAES-S-020.

5.13 Fire Protection for Hydrocarbon Storage Facilities

5.13.1 Fire water demand for floating-roof tanks over 60 m in diameter for crude oil and other flammable products shall be based on the greatest of the three considerations below; total fire water need not exceed 252 L/s (4000 gpm):

a. Seal-rim fire only. Water is needed for foam generation as required by SAES-B-018, plus water from hydrants/hose streams for cooling the shell of the involved tank. Cooling water shall be calculated using 0.07 L/m²s (0.10 gpm/ft²) applied to shell area above the liquid level or roof level, assuming the tank to be half full, limited to 158 L/s (2500 gpm) per tank.

b. Fully-involved tank fire with the roof lost. Cooling water shall be provided to tanks downwind of the burning tank within 1½ tank diameters and within one quadrant. Water for cooling by fire hose streams shall be provided for a maximum of three tanks, based on 0.07 L/m²s (0.10 gpm/ft²) for major exposed surfaces, limited to the upper half of shells and 50% of the periphery of one tank and 25% of the periphery for each of the other two tanks.

Commentary Note on b:

Since this type of incident has a low probability, fixed foam systems are specified to help fight seal rim fires and are not intended to extinguish a fully involved tank fire. Therefore, water demand is based on the amount of cooling water necessary to prevent the fire from spreading to adjacent tankage.

c. Tank pump-over or boil-over resulting in a fire inside the diked area. Water shall be provided for making finished foam to be applied at a density of 0.11 L/m²s (0.16 gpm/ft²) to the largest diked area (but subtracting the area of the tank) times 1.5 (wastage factor).

5.13.2 For floating-roof tanks 60 m in diameter and less for crude oil and other flammable products, fire hydrants shall be provided as described in Section 7.

5.13.3 Ordinary fixed (cone) roof tanks above a certain size (See SAES-B-005) are normally not used for storing crude oil or flammable liquids. Where such tankage exists, hydrants shall be provided as described in Section 7, and such additional fire protection equipment shall be provided as specified by the Chief Fire Prevention Engineer.

5.13.4 For other design requirements for foam fire protection systems, see SAES-B-018.

Commentary Note:

For existing hydrocarbon storage facilities, the need for retrofit of fire protection systems should be assessed by the Chief Fire Prevention Engineer or his representative. Recommendations can then be prioritized and acted upon by the responsible Safe Operations Committee (SOC).

5.14 Residential Areas and Support Facilities

5.14.1 Selection and location of fire water protection systems shall meet the requirements of SAES-B-019 (Table 1) and SAES-B-014.

5.14.2 The fire water system may also be used as a utility water distribution system in accordance with SAES-S-040.

5.14.3 Automatic sprinkler systems in buildings shall be installed where required by SAES-M-100 (see this standard, paragraph 10.10).

5.14.4 Fire water protection for maintenance shops, storage areas, laboratories, and warehouse facilities, if required, shall also meet the requirements in UFC Table 81-A, NFPA 231, and NFPA 231C as practicable.

5.15 Fire Protection for Loading Racks

The fire water demand created by loading racks shall be determined per SAES-B-070.

5.16 Barriers for Protection of Exposed Firefighting Equipment and Fire Water Piping

5.16.1 Fire hydrants, monitors, hose reels, and fire water piping and valving generally do not require barrier protection inside plants. Along curbed roadways, hydrants should be protected against vehicular damage by locating them so that they are protected by the curb. Barriers are not allowed along thoroughfares or residential or light industrial area streets.

5.16.2 Fire protection equipment is sometimes exposed to a high probability of damage from reversing traffic in process facility areas or other light industrial settings, such as warehouse parking lots and lay-down yards. In these circumstances, posts, using drawing AD-036010 as a guideline for post construction, or roll curbs shall be installed on the traffic exposed side only. A barrier shall not impair emergency access to the equipment or its operation.

Commentary Notes:

Barriers have been overused in the past. They are expensive, require periodic maintenance (painting), and frequently interfere with fire hose connections. Barriers should not be used in residential and light industrial areas since they create a potentially lethal hazard near roadways.

It is recommended that existing barriers be evaluated. If the barrier interferes with use of the fire hydrant per the Fire Protection Department, it shall be modified or removed. Barriers should be removed from main roadways.

5.17 On distillation columns and reactor structures, a nominal 100 mm (4-inch) riser with a twin fire department 2½-inch gated "Y" inlet at 1 meter above grade shall be provided. 2½-inch fire department single valved outlets shall be provided at each level where a manway is located and on other strategic walkway levels that the Chief Fire Prevention Engineer or his representative shall specify. An automatic air bleed valve to relieve air pressure during filling of the riser shall be installed at the top of the riser. All inlets and outlets shall be provided with caps.

Commentary Note:

This is provided to fight column fires using a fire department pumper truck, such as a fire caused by ignition of pyrophoric materials during T&I Operations.

6 Supply and Storage

6.1 Design Basis

Every fire water system shall be supplied from dedicated fire water storage. The storage shall contain a volume of water sufficient to provide the design flow rate, for the duration stated below, to the most demanding risk area (capacity design basis). Tankage may be used for fire water and for utility water provided the suction connection for the utility water pumps is high enough on the tank to ensure the required fire water supply is available when utility water suction is starved.

6.2 Storage Capacity

The required storage capacity shall be sufficient to provide fire water for durations as follows, with a primary supply providing 100% of the design basis flow and a secondary supply providing 50% of the design basis flow:

	Primary 100% Flow	Secondary 50% Flow
High- and Medium-Risk Areas	6 hours	12 hours
Hydrocarbon Storage Facilities	6 hours	12 hours
GOSPs	4 hours	none
Low-Risk Areas	4 hours	none
Flammable/Combustible Warehouses	4 hours	4 hours
Utility Areas, Shops	2 hours	4 hours
Residential And Support Services	4 hours	none

6.2.1 In locations where a reliable supply of water is available, provisions shall be made to provide a minimum of 50% of the design flow indefinitely. An example would be seawater back-up to a fresh water system.

6.2.2 The supply of fresh water may be reduced to 2 hours if 100% seawater back-up is provided.

6.2.3 When seawater is used, a chlorination, hypochlorination, or other system shall be provided to prevent the growth of marine organisms in pump suctions, pump caissons, and other piping systems susceptible to their growth. Systems shall be capable of being adjusted to provide down to 1 ppm of free chlorine to the inlet of the source pump suction. A system shall be provided to monitor the chlorine concentration entering the pump.

6.2.4 Fire Water Quality

It is preferable for the primary supply of water to be fresh water (as defined in SAER-5248). If the water supply is brackish, chemical injection or other means of water treatment should be considered in system design to reduce corrosivity, scaling/fouling tendency, and other undesirable factors.

6.3 Special Requirements for Fire Water Tanks

6.3.1 Design

Fire water storage tanks shall comply with SAES-D-100.

6.3.2 Internals

The lining and internals of tanks shall be compatible with all types of water anticipated as being a source of fire water.

6.3.3 Piping Connections

All piping connections to a tank used as a reservoir, other than suction lines to the fire water and jockey pumps, shall be located at a point above the level required to contain the minimum volume per Section 6 in that tank.

6.3.4 A fire water tank low level alarm shall be installed with annunciation at the appropriate manned control facility.

6.4 General Equipment Layout

A summary for general fixed fire protection equipment requirements is included in Table 1 of SAES-B-019.

7 Hydrants

7.1 Location

7.1.1 Hydrants shall be provided in Saudi Aramco facilities which have:

a. A dedicated fire truck, or

b. A Saudi Aramco Fire Protection Dept. fire station located within 2 hours by road.

7.1.2 Hydrant spacing shall be provided as follows:

Classification	Spacing Between Hydrants (max.)**	Space Between Hydrants And Protected Structures	
		Minimum	Maximum
Process : High-Risk : Medium-Risk : Low-Risk	60 m (200 ft) 60 m (200 ft) 90 m (300 ft)	15 m* (50 ft) 15 m* (50 ft) 15 m (50 ft)	75 m (300 ft) 75 m (300 ft) 75 m (300 ft)
Utility	90 m (300 ft)	15 m (50 ft)	75 m (300 ft)
Tankage and other offsite plant areas	90 m (300 ft)	15 m (50 ft)	75 m (300 ft)

* For high-risk and medium-risk areas, some hydrants with good road access shall be spaced at least 30 m (100 ft) from any protected equipment or structures, so that fire trucks can be safely positioned for long-term firefighting operations.

** Refer to Table 1 of SAES-B-019.

Exception:

A hydrant shall be located within 23 m (75 ft) of any foam manifold for the foam protection of rims of floating roof tanks. Refer to SAES-B-018 for additional information on fire protection of storage tanks.

7.1.3 Hydrants shall not be located inside tank dikes or in drainage swales.

7.1.4 Hydrants shall be numbered and clearly stenciled on the riser. The numbering system shall be coordinated with the Fire Protection Department before entering or updating these numbers in the drawing system.

7.2 Hydrant Selection and Design

7.2.1 Hydrants used in process, storage, and utility facilities shall be selected from:

Type 509-E: Risk areas with a demand of 32 L/s (500 gpm) or less, and where pumpers are not usable.

Type 509-G: Risk areas with a demand of more than 32 L/s (500 gpm), up to and including 126 L/s (2000 gpm).

Type 509-K: Risk areas with a demand of greater than 126 L/s (2000 gpm).

7.2.2 Hydrant design, valves, and flange connections shall either comply with Figure 1 or purchase commercially available manufactured hydrants that are functionally the same, meet the requirements of Section 7.2, and have the same riser flange connection. Commercially available hydrants and valves shall be technically reviewed and approved by the Chief Fire Prevention Engineer and the General Supervisor, P&TS Div., Fire Protection Department prior to purchase. Provide model and details with request for approval. Hydrants shall meet the following criteria:

a. Hydrants shall be rated for a minimum of 64 L/s (1000 gpm) in high-risk areas.

b. Hydrants shall be rated for a minimum of 47 L/s (750 gpm) in medium-risk areas.

c. Hydrants shall be rated for a minimum of 32 L/s (500 gpm) in low-risk areas.

d. Hydrants shall be a wet barrel type with no internal valving or integral foot (internal subgrade shutoff) valves.

e. Hydrant outlet valves shall be listed to meet the requirements of NFPA 1963 and shall be compatible with the mobile / firefighting equipment from the local fire station of the Saudi Aramco Fire Protection Department. Handwheels shall not be provided or installed on the valves.

Exception:

For areas protected by Municipality or other local fire departments, such as Saudi Aramco-built Government Schools, outlet valves shall be compatible with the equipment of that fire department.

f. Outlet valves shall be a minimum of 600 mm (24 inches) and maximum of 1200 mm (48 inches) above finished grade. The bottom flange shall be a minimum of 125 mm (5 in) above finished grade (See Figures 1 and 2).

g. Isolation valves between the hydrant and fire water main, if provided, shall be buried in accordance with SAES-S-040. Risers to hydrants shall be installed in accordance with Figure 2 of this standard. For anchoring a riser from a plastic or RTRP header, also refer to Figure 2.

Commentary Note:

There is no requirement for a valve at the T-junction where the hydrant lateral connects to the fire main, since main isolation valves specified in Section 12, provide sufficient isolation capability for hydrant maintenance.

7.3 Access

7.3.1 Where hydrants are installed adjacent to pipelines, fences, ditches, and dikes, hydrants shall be accessible from a roadway or designated access way.

7.3.2 Hydrants shall be located within 6 m (20 ft) of roads or access ways suitable for access by a fire truck. A level working area shall be provided for a 3 m (10 ft) radius around each hydrant, unless approved by the Chief Fire Prevention Engineer or his representative.

7.3.3 Fire hydrants in residential and service areas shall be located on the street side of houses or buildings.

Exception:

If there is some advantage or need to use the utility alley, hydrants may be located in the alley. An alley used for this purpose shall be wide enough to accommodate two-way fire truck traffic (a minimum of 6 m wide), shall be clear of other obstructions, such as trees and shrubs, and shall have access to a street on either end of the alley.

7.3.4 Underground piping, valves, and fittings shall be externally protected against corrosion per SAES-X-600.

7.3.5 For direct-buried block valves, refer to Section 12.11.

8 Hose Reels

8.1 Areas Requiring Hose Reel Coverage

8.1.1 Coverage of all ground-level vessels and equipment by at least one live hose reel shall be provided as follows:

a. Process areas.

b. Utility areas for process areas.

c. Combustible/flammable yard storage; inside warehouses, labs, industrial shops, and construction camp buildings.

d. Scraper traps located in plant areas.

8.1.2 Coverage by two live hose reels shall be provided where two monitors are required as specified in Section 9.1.

8.2 Design and Construction

Live hose reels shall be constructed in accordance with SAMS 21-219-834 using Figure 3 for guidance. Design improvements are allowed upon review and approval of the Chief Fire Prevention Engineer and the General Supervisor, P&TS Div., Fire Protection Department or their representatives.

8.3 Installation

8.3.1 Clear Space Requirement

A minimum clear space of 4.5 m (15 ft) shall be provided in front of every live hose reel cabinet to allow proper hose withdrawal.

8.3.2 Orientation to Equipment

Live hose reel cabinets shall be located such that all equipment that they are intended to protect can be so protected without kinking the hose.

8.4 Special Hose Reel Requirements

In addition to the general design requirements given above, the following are applicable:

a. A throw of 7.5 m (25 ft) shall be assumed when estimating available coverage. Hose reels shall be provided with 38 m (125 ft) of 1¼-inch firm type rubber-covered and rubber-lined booster hose.

b. Live hose reels covering shops and other buildings shall be located inside the buildings and shall be positioned adjacent to exits. All areas of the building interior shall be covered by at least one hose.

c. In process facilities, live hose reels shall be a minimum of 7.5 m (25 ft) from the equipment being protected.

d. On high structures, such as fluid cat cracker (FCC) units, live hose reels shall be provided on landings within the structure.

e. On cooling towers made of combustible materials or containing combustible fill, live hose reels shall be mounted on the end of the walkway at the top of the tower.

f. Self-regulating valves shall be installed at each live hose reel to control the residual pressure at 1035 $kPa_{(ga)}$ (150 psig) when the system shut-in pressure exceeds 1035 $kPa_{(ga)}$ (150 psig).

8.5 Flat Folding Hose and Pin Racks

a. Apartment buildings, offices, schools, hospitals, laboratories, clubhouses, dining halls, theaters, and similar buildings shall be provided with stations for flat folding hose per Table 1 of SAES-B-019.

b. 1½-inch flat folding hose shall be a listed, rubber-lined, single synthetic-jacket fabric, in either 15 m or 30 m (50 ft or 100 ft) lengths, depending on required coverage (refer to SAMS 21-045-056). Hoses, nozzles, pin racks, angle valves, wrenches, and adaptors shall be mounted in a metal cabinet specifically designed and manufactured for this purpose. The door shall have a glass panel so that the contents are readily visible. Pin racks are required.

c. The nozzle shall be a combination spray/stream type with capability of continuous adjustment from shut-off through spray pattern to solid stream. Nozzles shall comply with SAES-B-019, Section 7.

9 Monitors

Fire water monitors shall provide coverage as listed below.

Exception:

Onshore GOSPs that are not inside a main plant area require only partial coverage as specified in 9.3.

9.1 Two-Monitor Coverage

The following equipment shall be protected by a minimum of two monitors:

a. Vessels (heat exchangers, drums, columns, and similar equipment) containing 19 000 L (5 000 gal) or more of flammable liquid at normal operating liquid level.

b. Heat exchangers, vessels, or other equipment containing flammable liquid or combustible gas at temperatures above 315°C (600°F) or above fluid autoignition temperature, whichever is lower.

c. Plate-type heat exchangers for flammable liquids or combustible gases.

d. Compressors handling combustible gas and having drivers over 150 kW (200 hp).

e. Pumps handling flammable liquid and having drivers over 75 kW (100 hp).

f. Any furnace which has a flow of flammable liquid, combustible liquid, or combustible gas through the tubes.

g. Any furnace fired with a flammable liquid fuel.

Commentary Note:

It is not the intent to require two monitors for each individual piece of the equipment listed above; rather, the intent is to ensure that each piece of equipment is reachable by two monitors without violating the monitor-to-equipment spacing requirements in Sections 9.4 and 9.7. For example, depending on equipment-to-equipment spacing, a total of either two, three, or four (but almost surely not five or six) monitors might be needed in order to provide adequate coverage for three pumps. Monitors must be spaced apart so

that good equipment coverage from at least one monitor will be possible, regardless of wind direction, spraying burning liquids, gas releases, etc.

Exception 1:

When it is impractical to protect equipment with monitors because of congestion, water spray or deluge protection shall be provided in lieu of monitors. Equipment that is protected by a water spray or deluge system does not require monitor coverage. However, fire hydrant and hose reel coverage is still required.

Commentary Notes:

Where fire water is limited, and, in some cases, where manpower is limited, spray or deluge protection provides the best coverage for the water available. However, spray/deluge systems require proper design, careful installation, periodic testing, and (due to plugging concerns) are generally viewed as more troublesome and less reliable than monitors. Therefore, the decision to use spray/deluge protection rather than monitor protection generally is made solely on the basis of piping/equipment congestion which does not permit adequate spacing of monitors from equipment and interferes with proper coverage of equipment by monitor streams.

Where adequate water is available, concerns about plugging of sprays can be alleviated by designing spray systems that make use of 1½-inch NPT fixed-pattern monitor nozzles, field-adjusted for correct coverage. This approach, due to its simpler piping, is particularly desirable for protection of large pieces of equipment, such as compressors that need crane access for repairs.

Exception 2:

Unless required elsewhere in this Standard, monitor protection is not necessary above a height of 7.5 m.

Commentary Note:

The question frequently comes up about coverage of tall columns, etc. In most cases, for equipment that extends far up into the air, it is not practical to provide monitor coverage except for the lower part of the equipment, up to a height of about 7.5 m. Fire damage can occur at heights far higher than 7.5 m, but specialized equipment (such as straight-stream nozzles on portable monitors, supplied by Fire Protection Dept. and fed from a pumper truck) will be needed in this type of major fire situation. Fin-fan coolers are generally at a height where fixed monitor protection is impractical and need not be provided. Pipe racks that support only piping do not require monitor protection. Monitor protection sometimes has been provided for metering skids, but protection from hydrants and hose reels should be sufficient unless skids contain higher risk equipment such as pumps. Many crude oil manifolds in GOSPs have monitor protection, but hydrants should be adequate for new construction. However, crude manifold EIVs that shut off incoming crude to traps need coverage by at least one monitor.

9.2 One-Monitor Coverage

The following equipment shall be protected by at least one monitor:

a. All other process equipment handling flammable or combustible liquid or combustible gas and not noted in 9.1 or 9.3.

b. Scraper traps located in plant areas.

c. Manifold EIVs that shut off incoming crude to traps [See 9.3 (c)].

d. Oil-filled transformers associated with critical substations (per SAER-5558) and containing 7600 L (2000 gal) or more of insulating oil, if Fire Protection Department apparatus response is likely to be greater than five minutes.

9.3 Partial Coverage for Selected Onshore GOSPs

a. For onshore GOSPs that are stand-alone and not part of other plant facilities, complete coverage of surfaces of large horizontal vessels (traps, desalters, dehydrators) is not required. However, monitor coverage shall be provided for all inlet and outlet flanges, small-diameter piping connections, and bridles.

b. Compressors handling combustible gas and having drivers over 150 kW (200 hp), and pumps handling flammable liquid and having drivers over 75 kW (100 hp), shall be protected by at least two monitors.

c. All other process equipment shall be protected by at least one monitor. Monitor protection is not required for piping manifolds (production headers) for incoming crude where adequate spacing, isolation capability, and surface drainage exist, but manifold EIVs that shut off incoming crude to traps need coverage by at least one monitor.

9.4 Foam Monitors

In tank farms serving ship-loading operations, fixed foam water monitors of 32 L/s (500 gpm) capacity each shall be installed to deliver both water and 3% foam solution to crude oil booster/shipper pump facilities. Monitors shall be approximately 15 m (50 ft) from booster/shipper pumps being protected and located such that the pump area can be hit from two or more sides (upwind and cross-wind). The monitors shall be connected to the tank farm fire water system via a normally-closed isolating valve located upwind a minimum of 30 m (100 ft) from the nearest edge of the pump area. A hose-connection manifold having two 2½-inch hydrant valves (SAMS 04-790-003) for each monitor shall be installed a minimum of 30 m from the nearest curbing or drainage swale of the

pump area to enable delivery of water or foam solution from a fire truck to the pump area monitors. The fire hydrant(s) supplying the fire truck shall be no closer than 7.5 m and no more than 30 m in an upwind or cross-wind direction away from the hose-connection manifold. The manifold isolating valve shall be located in the vicinity of the hose-connection manifold. Supply hydrants and hose-connection manifold shall have road access.

Commentary Note:

With the isolating valve connecting the monitors with the water main normally closed, firefighters have a choice of pumping either foam or water in from the truck through the manifold to the monitors, or they can open the isolating valve to supply fire water to the monitors. Monitor valves should be normally open (see Figure 4, below).

9.5 Design Specifications

9.5.1 Monitors shall be designed in accordance with Figure 5.

9.5.2 Monitor and nozzles shall be as specified in SAMS 21-161-350 and SAMS 21-178-009, respectively.

9.5.3 Monitors shall be numbered and clearly stenciled on the riser. The numbering system shall be coordinated with the Fire Protection Department before entering or updating these numbers in the drawing system.

9.6 Rated Capacity

Monitors shall have a minimum rated flow of 32 L/s (500 gpm) at 700 $kPa_{(ga)}$ (100 psig) residual pressure.

9.7 Location Restrictions

9.7.1 Monitors shall be located a minimum of 15 m (50 ft) and a maximum of 30 m (100 ft) from equipment being protected.

9.7.2 Monitors shall not be located within 3 m (10 ft) of any catch basin or drainage channel or swale. Monitors shall not be located inside tank dikes or in drainage swales.

9.7.3 Attention shall be given to the extent to which adjacent objects will obstruct the pattern of coverage of monitors. Final design shall either remove the obstruction, reposition the monitor, or provide additional monitors.

9.8 Access

9.8.1 Except for elevated monitors, ready access shall be provided to all monitors. A level working area shall be provided for a 3 m (10 ft) radius around each monitor, unless approved by the Chief Fire Prevention Engineer or his representative.

9.8.2 Where elevated monitors are used to provide protection of congested equipment, they shall be operable from grade in terms of adjustment of water flow and horizontal and vertical movement.

10 Fixed Spray System

10.1 Spray systems shall be provided to protect equipment as follows:

a. Loading racks for LPG and flammable liquids as specified in SAES-B-070.

b. Equipment handling or storing tetramethyllead (TML) or tetraethyllead (TEL).

c. Compressors mounted on elevated platforms or in shelters and therefore cannot be adequately protected by monitors.

d. Cooling towers (including fill) built of combustible materials shall be covered by fixed spray/sprinklers per NFPA 214.

e. Other equipment noted in Section 9, when it cannot be adequately protected by monitors.

10.2 General Design

10.2.1 Fixed spray systems designed and installed by fully experienced and specialized parties.

10.2.2 Water spray systems shall be hydraulically balanced to maintain a water distribution rate within 15% of design density. Calculation procedures shall be per NFPA 15 and shall be submitted to the Chief Fire Prevention Engineer or his representative for review.

10.2.3 Each spray system shall be required to pass a performance test, witnessed by the Chief Fire Prevention Engineer and the General Supervisor, P&TS Div., Fire Protection Department or their representatives, prior to mechanical acceptance sign-off.

10.2.4 The design of the system shall follow requirements of NFPA 15, except as modified by this Standard.

10.3 Spray Performance Requirements

10.3.1 Spray nozzles shall have a minimum orifice diameter of 11 mm ($\frac{7}{16}$ in).

10.3.2 Spray nozzles shall be designed to discharge water through a single orifice.

10.3.3 Spray systems shall be designed to achieve the desired coverage of vessels and equipment with a minimum number of larger spray heads.

Commentary Note:

Particular attention must be paid to design and performance testing of spray coverage of vessel heads, since coverage in these critical areas frequently has been deficient in past designs.

10.3.4 Spray systems may be utilized to provide protection for more than one vessel and/or piece of equipment, provided all protected equipment/vessels are within the same risk area and the total calculated flow rate thorough a single spray system does not exceed 158 L/s (2500 gpm). Where demand exceeds 158 L/s, additional spray systems from ring main sections that can be isolated from one another shall be used, unless the Chief Fire Prevention Engineer concurs with demand in excess of 158 L/s from one ring main section.

10.4 Actuation and Alarm

10.4.1 Actuation normally can be by manual valve unless automatic actuation is required by other Saudi Aramco Engineering Standards or specified in 10.4.2.

10.4.2 Automatic detection and operation shall be provided when limited manpower is available or facility size is such that there could be a delay in manual activation time above 5 minutes, unless concurrence is obtained from the Chief Fire Prevention Engineer for a longer response time.

10.4.3 When automatic actuation is required, detection shall be achieved by fusible link or flame detection. Other means may be approved by the Chief Fire Prevention Engineer. Automatic valves shall be hydraulically operated and shall be listed for fire water service.

10.4.4 Automatic systems shall be fitted with an alarm actuated by flow, valve actuation, or other means. Alarms on water spray systems shall be located in a manned control facility supervising the affected risk area.

10.5 Piping Design

10.5.1 The spray system shall be considered to start at the inlet flange of the isolation valve connecting to the distribution piping. The spray system shall consist of an isolation valve, a strainer, actuation valve, and spray system piping. The entire spray system shall be located abovegrade.

10.5.2 Isolation and actuation valves shall be accessible from grade and shall otherwise meet the access requirements of SAES-B-054. A sign, written in Arabic and English, shall be prominently posted at each actuation valve stating its purpose and the vessel(s) and/or equipment being protected. This sign shall be capable of being read at 15 m.

10.5.3 Actuation valves shall be located a minimum of 15 m (50 ft), and preferably 30 m (100 ft), from equipment being protected. They shall not be located within 7.5m (25 ft) of any high fire potential equipment or within 3 m (10 ft) of a catch basin, drainage channel, or swale.

10.5.4 The entire spray system downstream of the isolation valve shall be capable of being drained by low point drains. The piping shall slope to the low points with a minimum slope of 1/165. If the fire water is not fresh water, flush-out connections shall be installed to allow flushing of the spray system with fresh water.

10.5.5 The strainer shall be located immediately upstream of the actuation valve. The strainer shall be of a type that can be cleaned while in service and shall be listed for fire service. Mesh in the strainer basket shall have a diameter no greater than one-fifth of the diameter of the smallest orifice in the spray system. The total area of screen openings for all strainers shall be at least three times the inlet pipe cross-sectional area. The valve used to clean the strainer shall be a minimum of 1½-inch nominal pipe size.

10.5.6 Spray heads shall be located such that spray patterns shall remain per design in a wind of 20 km/hr (12 mph).

10.5.7 Piping and spray heads shall be designed and installed so as not to impair operator, maintenance, or crane access to the equipment being protected. If it is impractical to maintain crane access, flanges shall be located to permit removal of spray system piping.

10.5.8 Attention shall be given to the extent to which adjacent objects, up to 1 m (3 ft) away, will obstruct the pattern of coverage by the spray nozzles. Final design shall either remove the obstruction, reposition the spray nozzles, or provide additional spray nozzles.

10.5.9 The branch piping to spray heads shall be connected to the top of distribution piping or supply ring, between the ten o'clock and two o'clock position, to minimize clogging of the heads. Refer to Figure 6.

10.6 Compressors

Spray systems for compressors shall comply with the following:

10.6.1 The entire skid area of the compressor shall be used in estimating fire water demand, plus any extra coverage needed for the 0.6 m (2 ft) envelope in 10.6.3.

10.6.2 Fire water demand shall be calculated based on providing a spray density of 0.34 L/m²s (0.50 gpm/ft²) over the skid area and envelope.

10.6.3 Sprays shall be designed to concentrate flow on the compressor, the seal area, and the lube oil/seal oil area, and not necessarily evenly over the skid. Spray coverage shall extend at least 0.6 m (2 ft) beyond the periphery of the casing, seals, and lube oil/seal oil area.

10.6.4 If a compressor lube oil/seal oil skid is located some distance away from the compressor it serves, it shall be protected as though it were a separate compressor, with a separate evaluation of congestion to determine whether to provide monitor protection or a water spray system.

10.6.5 If sufficient fire water is available, the preferred method of providing protection for compressors, especially those located under shelters, is by use of 1½-inch NPT fixed-pattern monitor nozzles mounted above the compressor or on the structural steel supporting the compressor shelter. This arrangement provides the most space for maintenance activities.

10.7 Pumps

10.7.1 Water sprays protecting pumps shall be designed to cover the pump casing and the horizontal area at least 0.6 m (2 ft) from the periphery of the casing. The suction and discharge flanges, casing drain valves, gauge connections, balance lines, and pump seals shall be included in the spray area.

10.7.2 Spray densities for pumps shall be 0.34 L/m²s (0.50 gpm/ft²).

10.8 Vessels

The design of spray systems for horizontal and vertical vessels shall comply with the following:

10.8.1 A fire water density of 0.10 L/m²s (0.15 gpm/ft²) of the protected area shall be used in calculating fire water demand, except for nonrefrigerated vessels containing TML/TEL, LPG, or NGL, for which a density of 0.17 L/m²s (0.25 gpm/ft²) shall be used.

10.8.2 For horizontal vessels, the protected area shall be defined as the surface area of the upper half of the vessel. If the normal liquid level is below the mid-point of the vessel, the surface area between the mid-point of the vessel and the normal liquid level shall also be protected.

10.8.3 For vertical vessels, a maximum rundown of 3.7 m (12 ft) between spray rings, and between the lower-most spray ring and normal liquid level shall be permitted.

10.9 Loading/Unloading Racks

Design of spray systems for loading and unloading racks shall be per SAES-B-070.

10.10 Residential and Service Area Buildings

Where automatic sprinkler systems are required, they shall be designed in accordance with the requirements of NFPA 13, SAES-S-050, and SAES-M-100. Drawings and hydraulic calculations shall bear the seal of a registered engineer or chartered engineer, who has at least five years of experience in sprinkler system design. Drawings and calculations shall be submitted to the Chief Fire Prevention Engineer or his representative for review. Provisions shall be made to facilitate frequent inspection, testing, and maintenance of sprinkler systems, as described in NFPA 25. Commissioning and testing procedures shall be submitted to the Chief Fire Prevention Engineer prior to the time of request to inspect for mechanical completion.

11 Fixed Deluge System

11.1 Fixed deluge systems shall be provided to protect spheres, spheroids, hemispheroids, and domed roof tanks containing flammable liquids.

11.2 The fire water demand for tanks/vessels due to fires located outside their enclosing dike walls may be reduced by splitting the protected area into quadrants, each consisting of a deluge head or heads with piping and header (if any) and fed by separate actuation valves (refer to Figure 7). The following shall be noted:

a. The deluge actuation valves to each quadrant may be located on a common portion of distribution piping.

b. The sign posted at each valve shall clearly designate which quadrant is protected by the head(s) fed by that valve.

c. The fire water demand due to fires outside the enclosing dike walls shall be reduced to the demand due to the quadrant(s) exposed to that fire (see SAES-B-18).

11.3 Fixed deluge systems shall be designed and installed by fully experienced and specialized parties.

11.4 Calculations shall be submitted to the Chief Fire Prevention Engineer or his representative for review.

11.5 Each deluge system shall be required to pass a performance test, witnessed by the Chief Fire Prevention Engineer and the General Supervisor, P&TS Div., Fire Protection Department or their representatives, prior to mechanical acceptance sign-off.

11.6 Piping Design

11.6.1 The deluge system shall be considered to start at the inlet flange of the isolation valve connecting to the distribution piping.

11.6.2 The system shall consist of an isolation valve, deluge valve, piping, and deluge heads.

11.6.3 The entire deluge system downstream of the connection to the distribution piping shall be abovegrade.

11.6.4 All deluge piping downstream of the deluge valve shall be capable of being entirely drained by low-point drain valves. Flushout connections shall be installed to permit flushing on the downstream side of the deluge valve with fresh water. Piping shall slope to the low points with a minimum slope of 1/165.

11.6.5 Where demand exceeds 158 L/s (2500 gpm), additional deluge systems from ring main sections that can be isolated from one another shall be used, unless the Chief Fire Prevention Engineer concurs with demand in excess of 158 L/s from one ring main section.

11.7 Manually Actuated Valves

11.7.1 Deluge valves may be manually operable except as specified in Section 11.8.

11.7.2 Manually operated deluge valves shall be located as follows:

a. A minimum of 30 m (100 ft) from any dike walls enclosing the vessel/tank being protected.

b. A minimum of 45 m (150 ft) from the vessel/tank being protected, if vessel/tank is not enclosed by the dike wall.

c. Outside any fire-hazardous area, as defined in SAES-B-006.

11.8 Automatically Actuated Valves

11.8.1 Automatic detection and operation shall be provided when limited manpower is available or facility size is such that a delay in manual activation time is likely. Response times above 5 minutes shall require automatic actuation of systems, unless concurrence is obtained from the Chief Fire Prevention Engineer for a longer response time.

11.8.2 When automatic detection is required, detection shall be achieved by fusible link, flame detection, or other means approved by the Chief Fire Prevention Engineer.

11.8.3 Automatic systems shall be fitted with an alarm actuated by flow, valve actuation, or other means. Alarms on water spray systems shall be located in a manned control facility supervising the affected risk area.

11.9 Remotely-Actuated Valves

11.9.1 Where layout precludes locating of the manual deluge valve per Section 11.7, or where automatic detection and activation is required by 11.8, the deluge valve shall be a hydraulically-operated valve listed for fire water service.

11.9.2 Where layout precludes locating of the manual deluge valve per Section 11.7, an actuation device for remote actuation shall be located as follows:

a. A minimum of 30 m (100 ft) outside of any dike walls enclosing the vessel/tank being protected.

b. A minimum of 45 m (150 ft) from the vessel tank being protected if not enclosed by the dike wall.

c. Outside any fire-hazardous area, as defined in SAES-B-006.

d. Control-room activation is optional and may not be substituted for an outside actuation device satisfying (a), (b), and (c) above.

11.9.3 The location of a deluge valve in a fire-hazardous area shall require the valve operator and associated power leads/air/hydraulic lines, to be fireproofed per SAES-B-006.

11.10 Deluge valves shall be accessible from grade and shall otherwise meet the access requirements of SAES-B-054.

11.11 A sign, written in Arabic and English, shall be prominently posted at each deluge valve or its actuating device, if any, stating its purpose and the tank/vessel being protected. This sign shall be capable of being read at 15 m (50 ft).

11.12 Estimation of Coverage Densities

11.12.1 The fire water demand shall be based upon densities applied over the "protected area" defined below. The following fire water densities shall be used:

Service	Fire Water Density
Vessels/tanks (non-refrigerated) containing LPG, NGL, TML/TEL	0.17 L/m²S (0.25 gpm/ft²)
Vessels/tanks in other flammable liquid service	0.10 L/m²S (0.15 gpm/ft²)
Vessels/tanks containing combustible liquids	0.07 L/m²S (0.10 gpm/ft²)

11.12.2 The minimum protected area for spheres and spheroids shall be the surface area above the maximum diameter of the vessel/tank.

11.12.3 Where the liquid level under normal operating conditions of spheres and spheroids is below the maximum diameter of the vessel/tank, the protected area shall include the surface area between the top of the vessel/tank and the normal liquid level.

11.12.4 Water flood connections to spheres and spheroids shall be as specified in SAES-B-057.

11.12.5 Where the normal liquid level of spheres is below the maximum diameter of the vessel, a ring of water sprays shall be added to protect the area of the shell that is not wetted by the deluge system due to interference by the legs. When this added water spray is used, a strainer per 10.5.5 shall be installed on the supply to the water spray.

11.12.6 The minimum protected area for hemispheroids and dome-roof tanks shall be the roof area.

11.12.7 Where the tank walls exceed 23 m (75 ft) in height, the protected area shall include the roof and the surface area between the roof and the mid-point of the tank walls.

11.13 Layout of Deluge Heads

The layout of deluge heads shall, in addition to the general requirements of Saudi Aramco Standard Drawings, ensure a uniform coverage of the protected area, irrespective of vessel/tank appurtenances. The following shall be noted in achieving this:

11.13.1 The use of a single deluge head and overflow weir to achieve coverage is permitted only for spheres of 13.7 m (45 ft) diameter and less, and spheroids, hemispheres, and dome-roof tanks of 16.8 m (55 ft) diameter and less.

11.13.2 A preferred method of installation is for a ring header with multiple deluge heads to be constructed around the main concentration of appurtenances on top of the vessel/tank.

11.13.3 A deflector plate shall be mounted around the roof-to-wall seams for hemispheroids and domed roof tanks to direct runoff from the roof to the walls.

11.13.4 For tanks requiring more than 126 L/s (2000 gpm), multiple heads, up to a maximum of four (4), shall be installed. Where multiple heads are provided, they shall be spaced on a 6 m (20 ft) radius circle around the center of the dome.

11.13.5 To reduce large cooling water demands, systems with over 252 L/s (4000 gpm) demand shall be arranged to divide the flow into quadrants, so that water flow is directed to deluge heads on a tank's exposed quadrant only. This can require individual supply feeders to each deluge head or pair of heads, depending on exposure potential from adjacent tanks.

12 Piping

12.1 The fire water system piping shall encompass all piping, fittings, and valves extending from the supply source to the isolation valves for fixed fire equipment and entry points to buildings. The system shall not include fire water piping within buildings, which is covered by SAES-M-100, except for hydrotest requirements mentioned below. The water requirement for fire purposes in residential and support services areas shall be the combined water flow for firefighting needs and domestic usage. Sizing of mains shall take into account future expansions and future needs.

12.2 Fire water mains shall meet NFPA 24, except where SAES requirements exceed the NFPA requirements.

12.3 Provisions shall be made to facilitate frequent inspection, testing, and maintenance as described in NFPA 25, GI-1781.001, and GI-1782.001.

12.4 Every fire water system, including sections of piping, fittings, valves, pumps, and drivers, shall be designed to accommodate the failure of any one system component so that operation of the major part of the system can be restored with minimum down time. Block valves shall be provided to isolate failed components in accordance with the following:

a. Beginning from the downstream side of the suction valve on each fire water pump, the system shall be designed to provide at least 50% of the required flow and pressure to the protected area upon isolation of the failed component. Where the normal static suction pressure at the fire water pumps is 210 $kPa_{(ga)}$ (30 psig) or greater, dual suction lines from the supply source to the fire water pumps shall be provided to ensure that loss of one suction header will not result in loss of more than 50% of the capacity design basis.

b. Failure of a single element shall cause no more than four (4) fire protection devices (monitors, hydrants, fixed spray systems, deluge systems, etc.), not counting live hose reels, to be removed from service at a time. Also see 12.10.

c. When gate valves are used abovegrade, they shall be installed so that the stems are horizontal.

12.5 Material Selection

Piping shall be selected, protected, and installed as follows:

a. Piping materials shall be selected to comply with SAES-L-032.

b. For fixed water/foam piping or foam concentrate skid installations, materials shall comply with Section 8, SAES-B-018.

c. Metallic piping systems shall be selected per SAES-L-005/006/007/ 008/009/010.

d. Metallic piping coatings shall be per SAES-H-002 and corrosion protection per SAES-L-033.

e. Piping shall be installed per SAES-L-050, SAES-L-011, or SAES-S-070, as appropriate.

f. Cathodic protection shall be provided per SAES-X-600.

g. In systems using RTR piping, the need for surge (water hammer) damping protection shall be studied. If the study shows a need, then damping shall be designed and installed to provide surge protection.

12.6 Hydrotesting Requirements

a. Hydrotesting of new construction, repair or renovation of fire protection systems shall meet the requirements of SAES-A-004 except as modified by the following:

b. For aboveground piping, or for underground piping prior to burial, newly-installed or newly-repaired fire protection systems in water service, regardless of materials, shall be hydrostatically tested to 1380 $kPa_{(ga)}$ (200 psig) or 345 $kPa_{(ga)}$ (50 psi) in excess of normal operating pressure, whichever is greater, and held without pressure loss for 4 hours. All piping is required to be hydrotested, including that of open ended piping for deluge or spray systems.

c. For underground installations, test duration shall be 24 hours if piping welds and joints cannot be left exposed during testing. All hydrostatic tests of fire water systems shall be recorded continuously.

d. Safety procedures in GI-0002.102 shall be followed during pressure testing.

e. The following requirements apply to newly-installed dry-pipe fire protection systems or combined dry-pipe preaction systems, as defined in NFPA 13. In addition to the standard hydrostatic test in (b) above, an air pressure leakage test at 275 $kPa_{(ga)}$ (40 psig) shall be conducted for 24 hours. Any leakage that results in a loss of pressure in excess of 10 kPa (1.5 psi) for the 24-hour period shall be corrected.

12.7 Fire Water Pump Suction Piping

a. Suction piping shall be installed abovegrade. Valves on the immediate suction of the pumps shall be car-sealed open.

b. A pressure gauge shall be installed immediately upstream of each fire water pump.

Exception:

Not required on systems utilizing submersible or lift pumps from the sea or other "natural" sources.

12.8 Fire Water Pump Discharge Piping

a. Discharge piping and the discharge manifold (if any) shall be abovegrade from pumps to the downstream side of all fire water pump and jockey pump discharge connections. Valves on the immediate discharge of the pumps shall be car-sealed open.

b. A pressure gauge shall be installed between the discharge flange of every fire water pump/jockey pump and its isolation valve.

c. Pressure switches and pressure tap valves shall be installed downstream of the pump discharge block valve.

d. Check valves shall be provided on the discharge of all fire water pumps upstream of the discharge block valves. Check valves shall not be permitted elsewhere in the fire water system, except as required by this Standard.

12.9 Distribution Piping

a. No distribution main piping shall terminate in a dead end. The mains of the water distribution piping network shall be laid out in closed loops with dual supply. For branch piping, see 12.10 below.

b. The minimum permissible size of distribution piping is 200 mm (8 in) in process areas and 150 mm (6 in) in other areas.

c. Within or near plant process areas, fire mains shall be installed underground. Depth of cover for fire exposure protection shall be a minimum of 150 mm (6 in). However, greater depth may be required per SAES-L-046 for surface load distribution. In tankage and other offsite plant areas and when over 7.5 m (25 ft) outside plant battery limits, lines may be installed aboveground on sleepers. Consideration must be given to drainage patterns, exposures to fire, and vulnerability to mechanical damage in routing these lines. Sections of piping that are located in fire-exposed areas shall be buried or fireproofed per SAES-B-006 for two hours, assuming no-flow condition.

d. Locating fire water lines in major pipeways is not allowed except under the following conditions:

i) The pipeway is above grade.

ii) The pipeway is well-drained with fire stops to prevent the longitudinal flow of spills.

iii) Fire water valves and hydrants are not located in pipeways.

iv) Fire water lines are situated on one side of the pipeway with the grade sloped towards the pipeway's other side.

e. An averaging flow meter for local meter hook-up shall be installed such that every fire water pump may undergo flow tests without impairing the availability of the system. The meter shall be located in the bypass piping from pump discharge to source of supply. The meter shall not restrict flow to the system. See Figure 9.

f. Flow measurement devices shall not restrict the design flows to any risk areas served by the fire water system.

12.10 Branch Piping

a. Branch piping shall feed no more than four (4) fire protection devices, excluding live hose reels.

b. The fire devices located on a single branch line shall constitute no more than 50% of the devices available to protect any single piece of process equipment.

c. Branch piping shall be buried.

d. The minimum size of any branch line shall be 100 mm (4 in), except as allowed in (e) below.

e. A branch supplying one hose reel may be a minimum of 50 mm (2 in) in diameter for a maximum length of 15 m (50 ft).

f. Permanent connections to scraper traps, utility systems, safety showers, process equipment, or vessels are prohibited. Temporary connections to scraper traps, process equipment, or vessels may be allowed if provided in accordance with SAES-L-041.

12.11 Block Valves

a. All belowgrade block valves in plant areas shall either have their stems protruding abovegrade or be equipped with position indicators abovegrade. Direct-buried block valves shall be post-indicator type and shall be installed per Figure 8. Valves that are closed for any reason shall be tagged as being out-of-service according to GI-0006.012.

Commentary Note:

The intent of this requirement is that the open or closed position of any fire water block valve be readily ascertainable by someone at grade. For valves that are belowgrade but not direct-buried, the intent can be met either by using post-indicator valves or by using ordinary gates or other acceptable type valves that have been demonstrated to perform satisfactorily and the position is clearly visible abovegrade. However, direct-buried block valves shall be post-indicator type.

b. All block valves shall be operable from abovegrade, except in residential and service areas.

c. Block valves located on abovegrade piping shall be accessible per SAES-B-054.

d. Block valves on underground piping and installed in plant area valve boxes shall comply with SAES-B-008.

Exception:

Valve boxes for fire water service block valves in plant areas may be allowed within 60 m of process equipment, within diked or impounding areas, or within pipeline corridors if permitted by the Chief Fire Prevention Engineer. If so permitted, valve boxes shall meet the following requirements:

1. Confined space entry procedures shall be enforced.

2. A warning sign requiring a permit to enter shall be installed near, or painted on, the valve box.

3. Valve service and valve number shall be marked clearly and prominently on the valve box.

4. The valve box entrance shall be kept locked and the key kept under the custody of operations.

5. The valves shall be operable from abovegrade.

6. The valves shall either have their stems visible abovegrade or be equipped with position indicators that extend abovegrade.

7. Locating deluge valves in a valve box is prohibited.

8. Hydrocarbon piping within the valve box is prohibited.

e. Each fire water system block valve shall have a unique and individual number on or near the valve to clearly identify it for isolation purposes and for reference on fire water system drawings. The numbering system shall be coordinated with the Fire Protection Department.

f. If a valve box is provided, valve service and valve number shall be marked clearly and prominently on the valve box entrance.

g. Underground valves and fittings shall be externally protected against corrosion per SAES-X-600.

12.12 Fire Boat Connections

A fire boat connection to pump into the distribution main shall be provided when sea water supply is (or may be) utilized and a fire boat or suitably equipped tug boat is available. Connection(s) shall be sized to provide at least half the capacity design basis fire water requirement for the complex, or full flow of the available boat(s), which ever is lower, assuming a boat pump discharge pressure of 1035 $kPa_{(ga)}$ (150 psig). The fire boat connection piping shall terminate with check valves(s) and blind flange(s) at an access work platform per SAES-B-054 (large enough to permit three people to maneuver and connect adapters and hoses from the fire boat).

12.13 System Drawing

Every fire water system shall be represented on a layout drawing, to scale, showing fire water and foam piping, sectionalizing and branch valves, foam tanks and proportioners, hydrants, monitors, deluge and sprinkler systems, hose

reels, fire boat connections, fire water tanks, pumps, and jockey pumps. For orientation purposes, major structures and major pieces of process equipment shall be indicated and identified on the drawing. The design basis capacity of the fire water system shall be stated on the drawing. The drawing shall be kept up-to-date.

13 Pumps

13.1 Provision of Fire Water Pumps

a. For process areas, the capacity design basis for fire water shall be furnished by two or more centrifugal pumps with electric motor drivers. In addition, standby capacity equal to at least 50% of the capacity design basis shall be provided by one or more diesel-driven pumps.

b. For nonprocess, support services, and residential areas, two or more pumps without standby are acceptable to furnish the capacity design basis, in which case one pump shall be diesel-engine-driven; the remaining pump(s) shall be motor-driven.

Exception (a) & (b):

Exceptions are permitted with the concurrence of the Chief Fire Prevention Engineer.

c. Fire water pumps shall be located only in electrically nonclassified areas.

13.2 Mechanical Design

13.2.1 All fire water pumps shall meet SAES-G-005. Provisions shall be made during facility design to accommodate frequent inspection, testing, and maintenance as described in NFPA 25.

Commentary Note:

Due to material requirements that exceed NFPA 20 pumps, unlisted fire water pumps are specified. Essential aspects of pump design that are in NFPA 20 are included in this section.

13.2.2 Diesel engine drivers and controllers for fire pumps shall be UL- or FM-listed for fire water service, but the associated pumps need not be listed. Drivers and pumps for electric motor driven fire pumps need not be listed.

13.2.3 The maximum allowable size for any one fire water pump is 126 L/s (2000 gpm) capacity, except as permitted by the Chief Fire Prevention Engineer.

13.2.4 Pumps utilizing untreated water directly from a natural source as a supply of fire water shall have a permanent suction strainer installed where required by NFPA 20, of a type meeting the requirements of NFPA 20.

13.3 Head Characteristics

13.3.1 All fire water pumps feeding the same fire water system shall have similar head characteristics.

13.3.2 The head characteristics shall allow the residual pressure requirements of Section 5.8 to be met; moreover, fire water pump discharge pressure at zero flow shall be not less than 860 kPa(ga) (125 psig).

13.3.3 All fire water pumps shall deliver at least 150% of rated flow at 65% rated head. The total shutoff head shall not exceed 140% of total rated head for any type of pump.

13.3.4 The head characteristic shall be constantly rising from operating point to pump shut-in.

13.3.5 A copy of the pump curve for each fire water pump shall be supplied to the Chief Fire Prevention Engineer.

13.4 Pump Drivers

13.4.1 The acceptable means of motive force (pump drivers) are electric motor or a listed diesel engine.

13.4.2 Each diesel engine shall be provided with a local, dedicated fuel tank. The minimum capacity of each dedicated fuel tank shall be such that the fire water storage capacity per Section 6.2 can be pumped by any one diesel driven pump without refilling its fuel tank, plus 10% extra for fuel expansion and the fuel tank sump.

13.5 Electrical Power Supply

Refer to SAES-P-114 and SAES-P-116.

13.6 Pump Testing

13.6.1 Engine-driven fire water pumps shall be provided with equipment and instrumentation needed to comply with the requirements specified in NFPA 20 regarding weekly start-up and run tests.

13.6.2 Flow and pressure of each fire water pump shall be checked at the design operating point, in conjunction with the tests required under NPFA 20.

13.7 Pump Location

13.7.1 Fire water pumps shall meet the spacing requirements of SAES-B-055.

13.7.2 Operator, maintenance, and crane access shall be provided per SAES-B-054.

13.8 Instrumentation

13.8.1 General pump instrumentation shall be as required by SAES-J-604. Only instrumentation specific to fire water pumps is noted below. Start functions, status indicators, alarms, and other functions, that are already located at the control room, shall be made available on the distributed control system (DCS), if available, even if those functions/alarms are also monitored on a separate dedicated fire panel.

13.8.2 Push Buttons

a. An individual push button shall be located adjacent to each fire water pump for the purpose of starting that pump manually.

b. Each fire water pump shall be stopped only by means of an individual push button located adjacent to the pump.

13.8.3 Operating Lights and Alarms

Operating (on/off) lights for each fire water pump shall be located at the pump and in a manned control facility. In the manned control facility, a visual and audible alarms shall meet NFPA 20 and shall otherwise indicate:

1) When a fire water pump starts.

2) When a pump's automatic/manual selector is switched to either MANUAL or OFF. If alarms are not available, the automatic/manual selector shall be locked in AUTOMATIC.

13.8.4 Remote Annunciation

a. Push buttons, audio/visual alarms, and operating lights located in manned control facilities shall be grouped together in suitable, central positions, and shall easily accessible by operators.

b. Push buttons, annunciators, and operating lights shall be clearly signposted as to the pumps affected and the risk areas served.

13.8.5 Automatic Start-up of Fire Water Pumps

a. Each fire water pump shall have an automatically initiated start-up system, independent of similar systems provided for other fire water pumps.

b. The controller for each fire water pump shall be listed. The controller shall receive a signal directly from a dedicated pressure switch located per Section 12.8.

c. Each pressure switch shall be set for no lower than 760 kPa(ga) (110 psig), unless other settings are approved by the Chief Fire Prevention Engineer.

d. The controller for each pump shall include an adjustable timer as part of the start-up circuit.

13.8.6 Pump Sequencing

When the system pressure drops to the setting per 13.8.5(c), the following pumps shall be sequentially started up by signals from their respective pressure switches (timers set to zero).

a. One electric motor driven pump.

b. Additional fire water pumps shall be started up automatically at 10-second intervals, as necessary to bring pressure up to the setting per 13.8.5(c).

c. If after the electric pumps are activated, fire water system pressure is still below 760 kPa(ga) (110 psig), engine-driven pumps shall be started at 10-second intervals, either until system pressure reaches the setting per 13.8.5(c) or until all pumps are running.

d. Failure of any one pump to start shall not prevent subsequent starting of other pumps.

13.8.7 Circuitry and Logic

The circuitry and logic to achieve the delayed automatic start-up of additional fire water pumps shall generally be designed as follows:

a. When the system pressure drops to the setting in 13.8.5(c), the pressure switch for each pump will be activated, which in turn will start their respective timers.

b. Upon completion of the timer cycle the signal from the pressure switch shall be relayed to the motor starter of their associated pump.

c. The timers will automatically reset when the signal from the pressure switch indicates that the pressure has risen to the setting in 13.8.5(c).

d. If the pressure recovery occurs before a timer completes its cycle, the associated pump will not start.

e. If the pressure recovery occurs after the timer cycle has completed its cycle and the pump has started, the pump will continue to run.

13.9 Multiple Electric Motor Driven Pump Systems

Where multiple electric motor driven pumps are utilized, the order of automatic startup shall be as follows:

13.9.1 The first pump to start (with timer set to zero) shall be the one of lowest flow capacity; subsequent pumps shall be set to start in ascending order of flow capacity.

13.9.2 When pumps of equal flow capacity are utilized, the one selected to start first shall be that on the most reliable bus; subsequent pumps shall be set to start in descending order of bus reliability.

13.9.3 When pumps of equal flow capacity are located on the same bus or buses of equal reliability, they shall have the required difference in settings of time delay; the order of sequence is then not important.

14 Maintaining System Pressure

14.1 Fire water systems of greater than 32 L/s (500 gpm) capacity shall have the piping downstream of the fire water pumps continuously maintained at a minimum of 875 $kPa_{(ga)}$ (125 psig), by means of a motor-driven jockey pump.

14.2 For installations requiring 32 L/s (500 gpm) of fire water or less, no jockey pump is needed except where fire water is also the utility water system. Then a small jockey pump is required, sized to meet utility demand and maintain loop pressure.

14.3 Fire water systems of over 32 L/s (500 gpm) shall be provided with one jockey pump rated at 19 L/s (300 gpm) at 875 $kPa_{(ga)}$ (125 psig), plus one 100% installed spare jockey pump. Systems that also supply utility water shall be provided with at least two 100% installed spare jockey pumps.

Exception:

Bulk plants and air fueling operations do not require spare jockey pumps.

14.4 System Pressure Control

Fire water pressure shall be controlled by recycling fire water from the pump discharge header back to the suction source of the pumps. The fire water pressure control system shall consist of a dedicated pressure transmitter, a pressure controller with adjustable set point, and a set of pressure control valves installed on the recycle manifold.

The pressure control valve system shall be sized to recycle a minimum flow of one half the design capacity of the smallest jockey pump and shall be designed to fail closed. The maximum recycle flow of the system shall be two times the sum of the design flows of one jockey pump plus the largest single fire water pump.

Commentary Note:

Normally multiple split-ranged control valves will be required for proper control over this flow range.

Fire water pressure control valves shall conform to SAES-J-700, "Control Valves", and 34-SAMSS-711, "Control Valves – General Service".

Exception:

For submersible pumps, pressure control valves shall be installed on each individual pump discharge line. The inlet piping to each pressure control valve shall be connected to each pump discharge, upstream of the check valve.

14.4.1 The pressure transmitter process connection shall be taken from a tapping on the fire water piping per Section 12.8(c).

14.4.2 Each pressure control valve shall be provided with an upstream and downstream manual isolation valves, designated "locked open". Other block valves on the pressure control valve branch and any located between a pressure control valve and the storage reservoir shall also be designated "locked open".

14.4.3 Pressure control valves shall be capable of easy removal without compromising the supply of water to the storage reservoir.

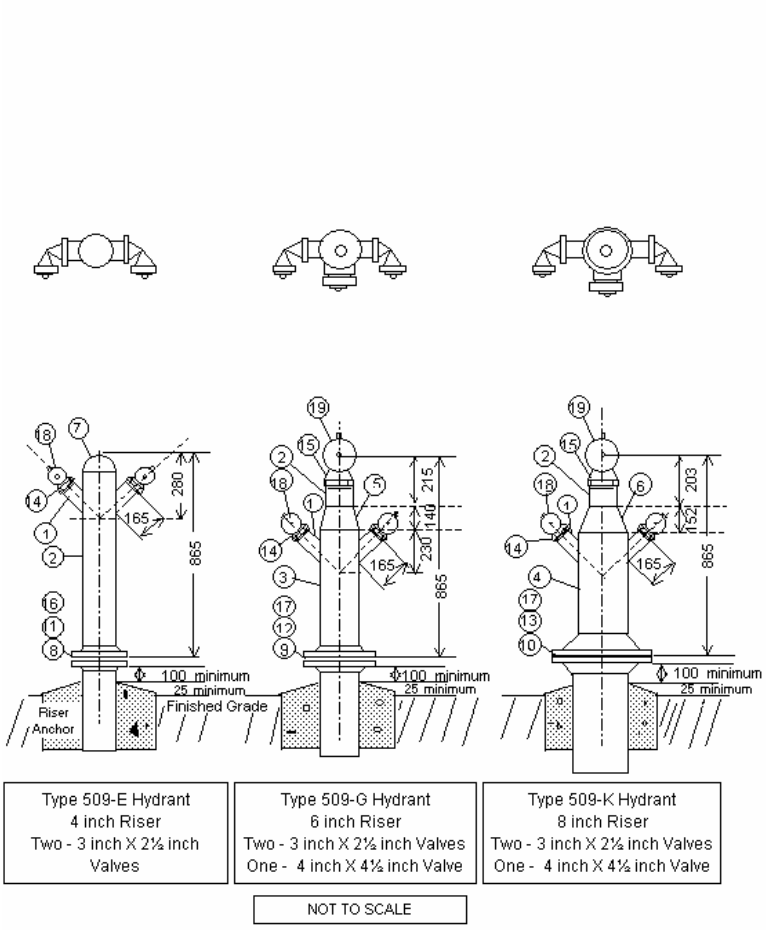
14.4.4 A pressure gauge shall be located immediately upstream of each pressure control valve.

14.4.5 A pressure relief valve shall be provided on the discharge of each engine-driven pump. Relief valve discharge shall be directed to the supply source.

14.4.6 For hose reel pressure protection, refer to 8.4 (f).

Revision Summary

15 March 2006 Revised the "Next Planned Update". Reaffirmed the contents of the document and reissued with no other changes.



1) Buried pipe shall be externally coated in accordance with SAES-H-002 up to the first flange above grade.
2) Hydrants shall be externally coated per APCS-6, SAES-H-101 and FBE internally coated per SAES-H-002, APCS-102, and 09-SAMSS-091.
3) 2½" X 3" and 4" x 4½" angle valves shall have the openings facing the street.
4) The riser / hydrant shall be flanged.
5) All dimensions are in millimeters (mm) unless noted otherwise.
6) List of material includes items for the hydrant only. Riser materials are extra. For riser details, refer to Figure 2.
7) Items 18 and 19 shall have a 1/16" diameter vent hole for pressure relief.
8) Manufactured hydrants that are functionally the same can be used instead. See 7.2.2.

LIST OF MATERIAL			Quantity		
Item	SAMS No.	Description (Hydrant Only)	E	G	K
1	01-167-275	Pipe: Metal; API 5L Grd. B; 3 in	2	2	2
2	01-167-390	Pipe: Metal; API 5L Grd. B; 4 in	1	1	1
3	01-167-545	Pipe: Metal; API 5L Grd. B; 6 in		1	
4	01-167-630	Pipe: Metal; API 5L Grd. B; 8 in			1
5	02-000-635	Reducer: 6X4; Concentric		1	
6	02-221-102	Reducer: 8X4; Concentric			1
7	02-100-317	Cap: BW; CS; 4 in	1		
8	02-394-842	Flange: W. N., R.F.; Cl. 150-4 in	1		
9	02-401-230	Flange: W. N., R.F.; Cl. 150-6 in		1	
10	02-394-849	Flange: W. N., R.F.; Cl. 150; 8 in			1
11	06-122-120	Gasket for 4 in 150 R.F. Flg.	1		
12	06-122-124	Gasket for 6 in 150 R.F. Flg.		1	
13	06-122-126	Gasket for 8 in 150 R.F. Flg.			1
14	04-790-003	Valve: Class 300; 3 x 2½ in	2	2	2
15	04-790-008	Valve: Class 300; 4 x 4½ in		1	1
16	10-354-372	Bolt Stud & nuts; 5/8 in x 89mm	8		
17	10-354-442	Bolt Stud & nuts; 3/4 in x 102mm		8	
18	21-048-380	Cap: for 2½ in Fire Hydrant Valve	2	2	2
19	21-048-329	Cap: for 4½ in Fire Hydrant Valve		1	1

Figure 1 - Welded Steel Fire Hydrant, Details

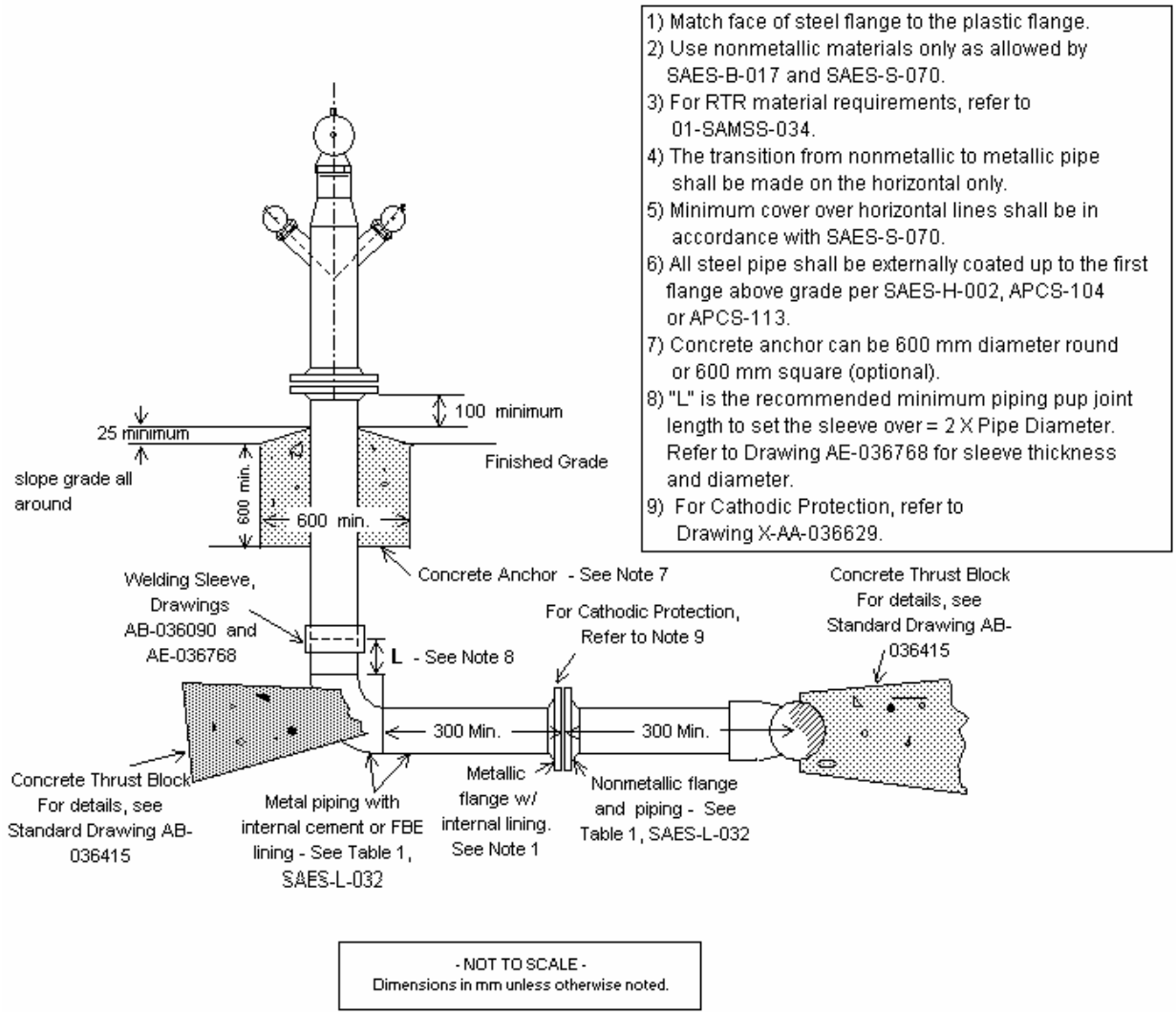


Figure 2 - Riser to Hydrant from Nonmetallic Water Main

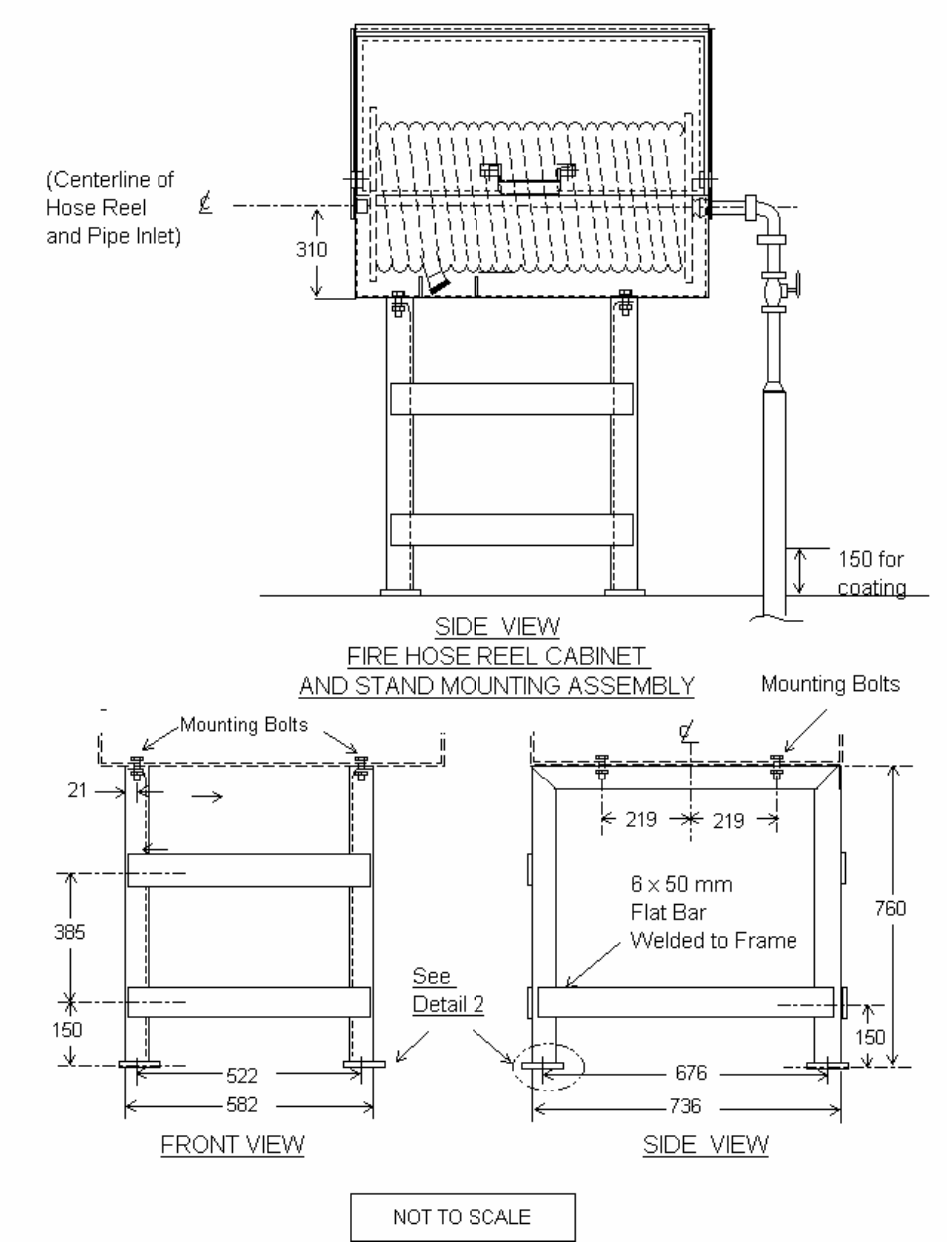


Figure 3 - Fire Hose Reel Cabinet
Typical Plan, Section and Details (Continued Next Page)

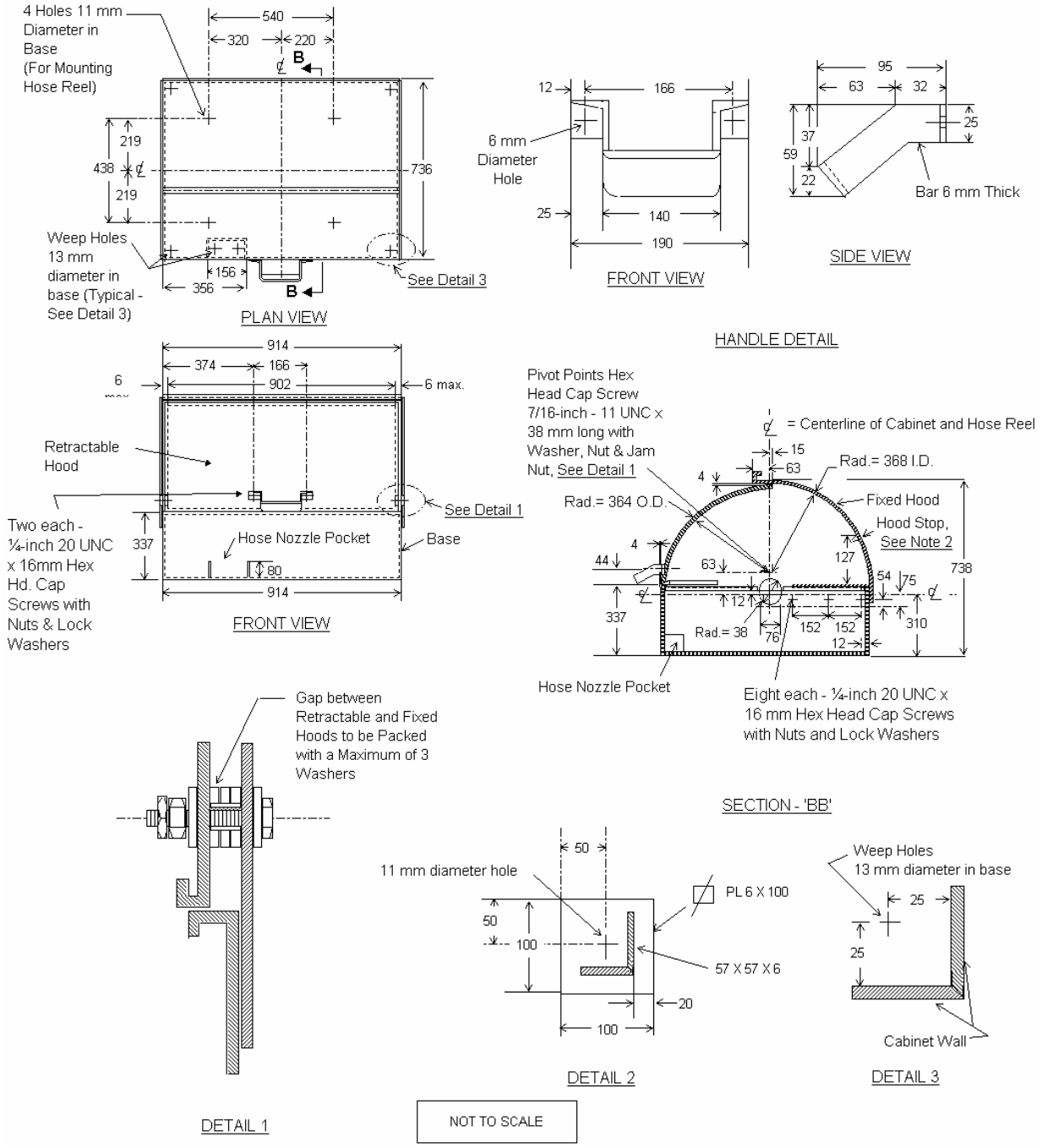


Figure 3 - Fire Hose Reel Cabinet Typical Plan, Section and Details

Notes:

(1) Cabinet assembly shall be same as SAMS 21-219-834. Cabinet stand shall be same as SAMS 21-250-834. Horizontal reel for stationary mounting shall be the same as SAMS 21-213-134 with manual right hand side rewind with 30-inch crank, 1½-inch NST female inlet to straight swivel joint and 1½-inch NST male outlet on drum.

(2) Hood stop L is 25 x 25 x 6 mm that is 152 mm long positioned on cabinet as shown in Figure 3. In order to mount, drill 2 holes 8 mm diameter at 50 mm intervals for ¼-inch (20 UNC) x 16 mm long hex head cap screws with nuts and lock washers.

(3) Entire cabinet to be fabricated from flat sheet steel 2 mm (14 gauge) thick.

(4) External and internal surfaces of cabinet to be prepared and coated red in accordance with Saudi Aramco SAES-H-101, APCS-6.

(5) Hose shall be 1¼-inch x 125 feet long pressure type 2 braid 300 psi working pressure with Buna-n tube, hypalon cover, and Barway type male and female 1½-inch NPS connections. Nozzle shall be 1½-inch brass industrial style same as SAMS 21-176-620.

(6) Supply branch piping for a hose reel shall be no less than 50 mm (2 in) nominal diameter and shall be externally coated to a point 150 mm above grade per SAES-H-002, APCS-104 or APCS-113.

(7) The rest of the hose reel piping shall meet Section 12 of this Standard and be coated same as the cabinet.

(8) All nuts, bolts, and washers shall be galvanized or better.

(9) For each production batch, the contractor is to manufacture one unit complete with hose reel for Saudi Aramco Vendor Inspection. On receipt of the Vendor Inspection approval, the contractor can proceed with the production run.

(10) All dimensions are in millimeters unless specified otherwise.

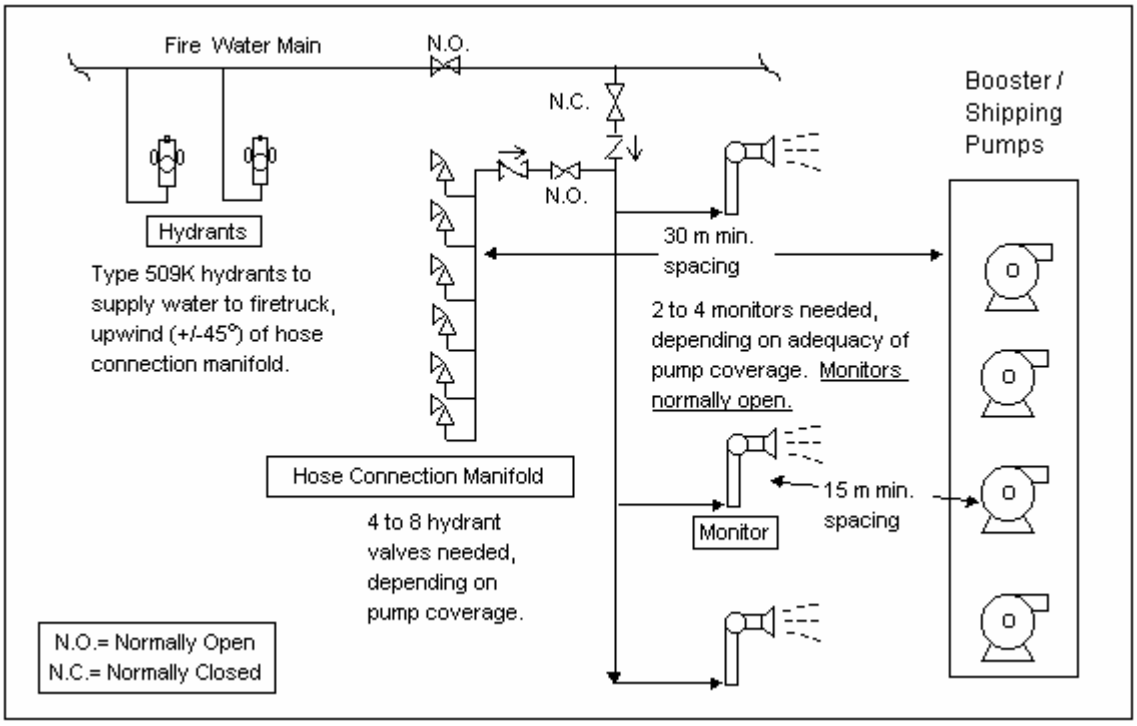
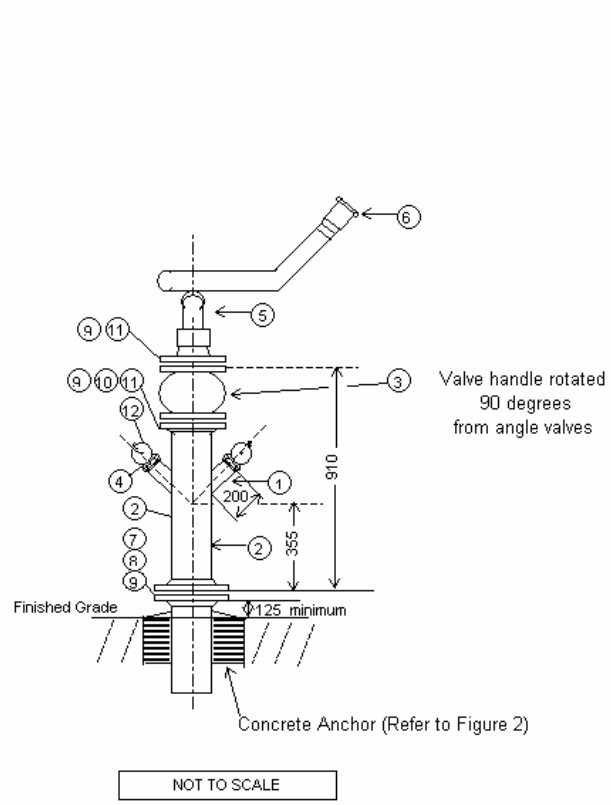


Figure 4 – Layout of Foam Monitor Protection for Booster/Shipping Pumps



1) Monitor station to be painted red and where exposed to traffic, protect with suitable curb or posts. Pipe from underground header to be coated per SAES-H-002 up to first flange.
2) Valve outlets to face plant equipment where applicable.
3) SAMS 01-167-275 and 01-167-410 including flanges shall be internally coated per SAES-H-002, APCS-102 and 09-SAMSS-091 after the monitor station has been fabricated.
4) Flat face flanges with full face gasket may be used instead of raised face for Items 7 and 8.
5) All dimensions are in millimeters (mm) unless noted otherwise.
6) Material List includes items for the monitor only. Riser materials are extra.

LIST OF MATERIAL				
Item	SAMS No.	Description (Hydrant Only)	QTY	Unit
1	01-167-275	Pipe: Metal; API 5L Grd. B; 3 in	1	m
2	01-167-390	Pipe: Metal; API 5L Grd. B; 4 in	1	m
3	04-210-264	Valve, Gate; 4 in; Cl. 125; FF	1	ea
4	04-790-003	Valve: Class 300; 3 x 2½ in	2	ea
5	21-161-350	Firewater Monitor; 4" ANSI Flat Base Fl. & 2½ inch NST. Male Outlet	1	ea
6	21-178-009	2½ inch Monitor Nozzle; 500 gpm	1	ea
7	02-401-222	Flange: W.N., R.F.; Class 150; 4 in	2	ea
8	06-122-120	Gasket for 4 in 150 R.F. Flg.	1	ea
9	10-354-372	Bolt Stud & nuts; 5/8 in x 89mm	24	ea
10	02-401-108	Flange: 4 in; Cl 150; FF	1	ea
11	06-138-255	Gasket; FF Ring; 4 in; Cl 150	2	ea
12	21-048-380	Cap: for 2½ in Fire Hydrant Valve	2	ea

Figure 5 - 2½-Inch Fire Water Monitor Station

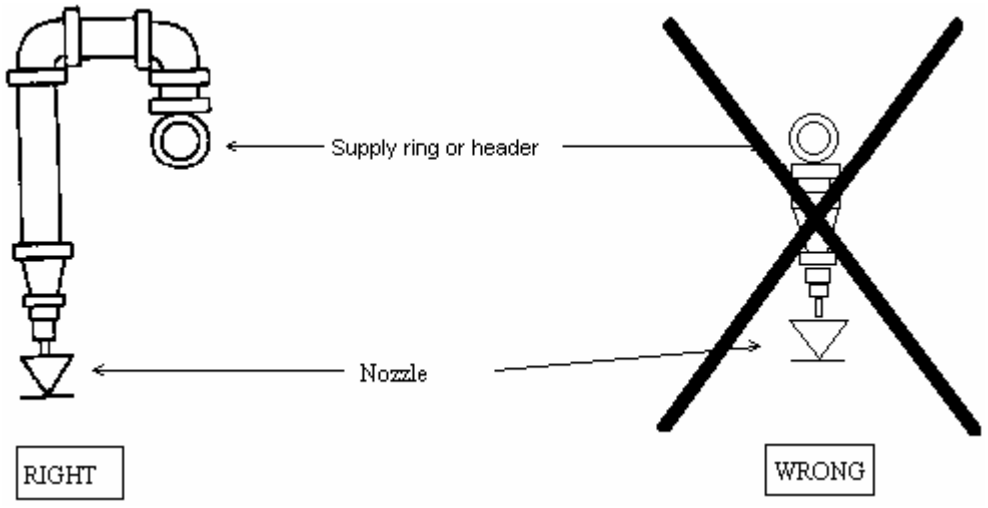


Figure 6 - Side View of Spray Branch to Illustrate Correct Orientation

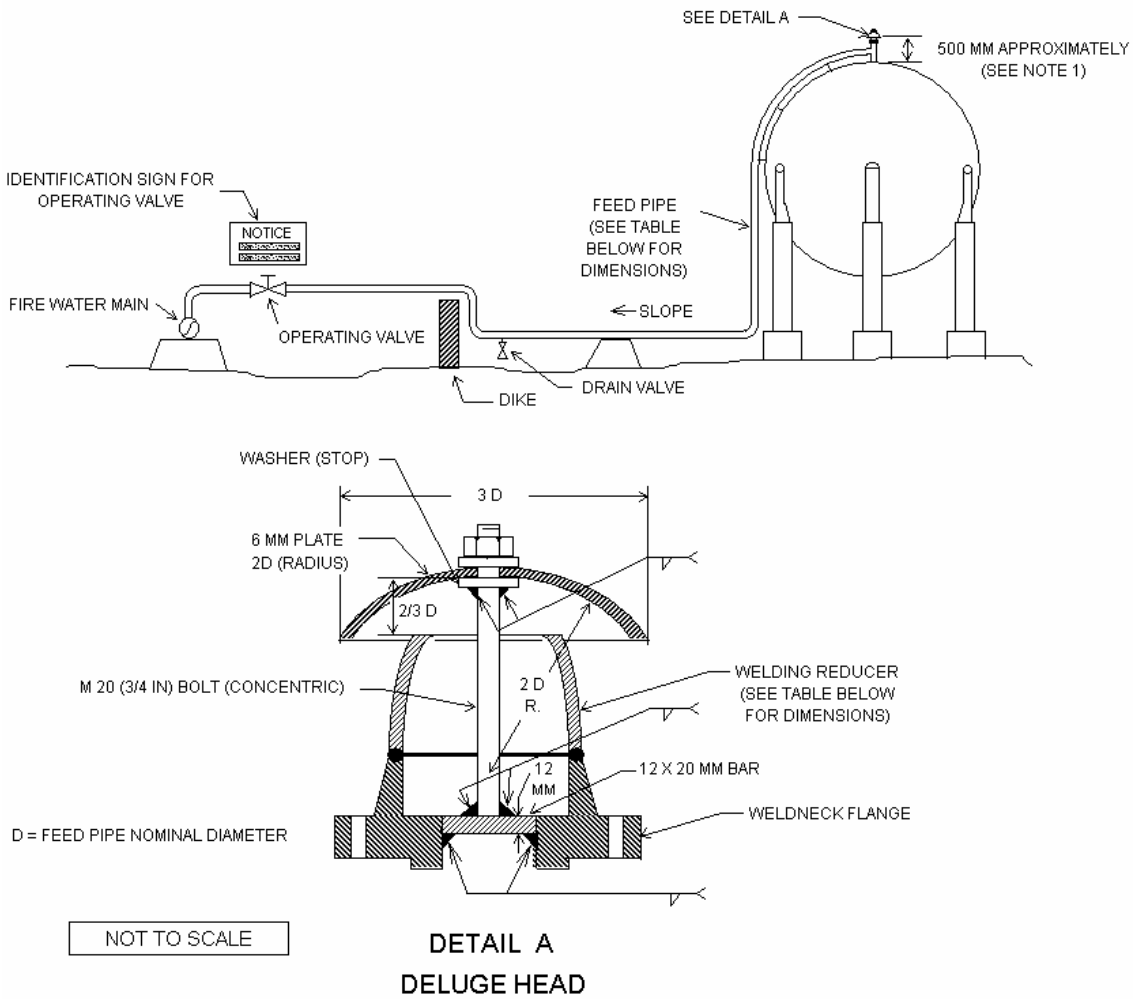


Figure 7 - Typical Piping Requirements for Deluge Systems

Sphere Diameter	Deluge Feed Pipe And Nozzle Dimensions			Flow Rate Per Nozzle L/S (gpm)
	Spheroid Max. Diameter	Deluge Feed Pipe Diameter	Deluge Nozzle Welding Reducer	
13.7 m	16.8 m	3 in. (Sch. 40)	3 x 1-½ in.	20 (315)
14 - 18.3 m	17 - 22.6 m	4 in. (Sch. 40)	4 x 2 in.	35.5 (560)
18.6 - 26 m	23 - 30.8 m	6 in. (Sch/ 40)	6 x 3 in.	71.3 (1130)
(2)	(2)	8 in. (Sch. 40)	8 x 4 in.	126.1 (2000)
(2)	(2)	10 in. (Sch. 40)	10 x 6 in.	246 (3900)

Notes:

(1) This dimension may be varied to permit the water to clear obstacles such as appurtenances and platforms. The nozzle should be located at the top dead center of the vessel. For larger vessels multi-heads system shall be provided (Refer to Section 11.13).

(2) For large diameter vessels than those indicated in the chart, a special design will be required to provide water a rate (Refer to Section 11.12).

(3) Upper limit based on noded spheroids at this diameter.

(4) Operating valve location per Section 11.7.

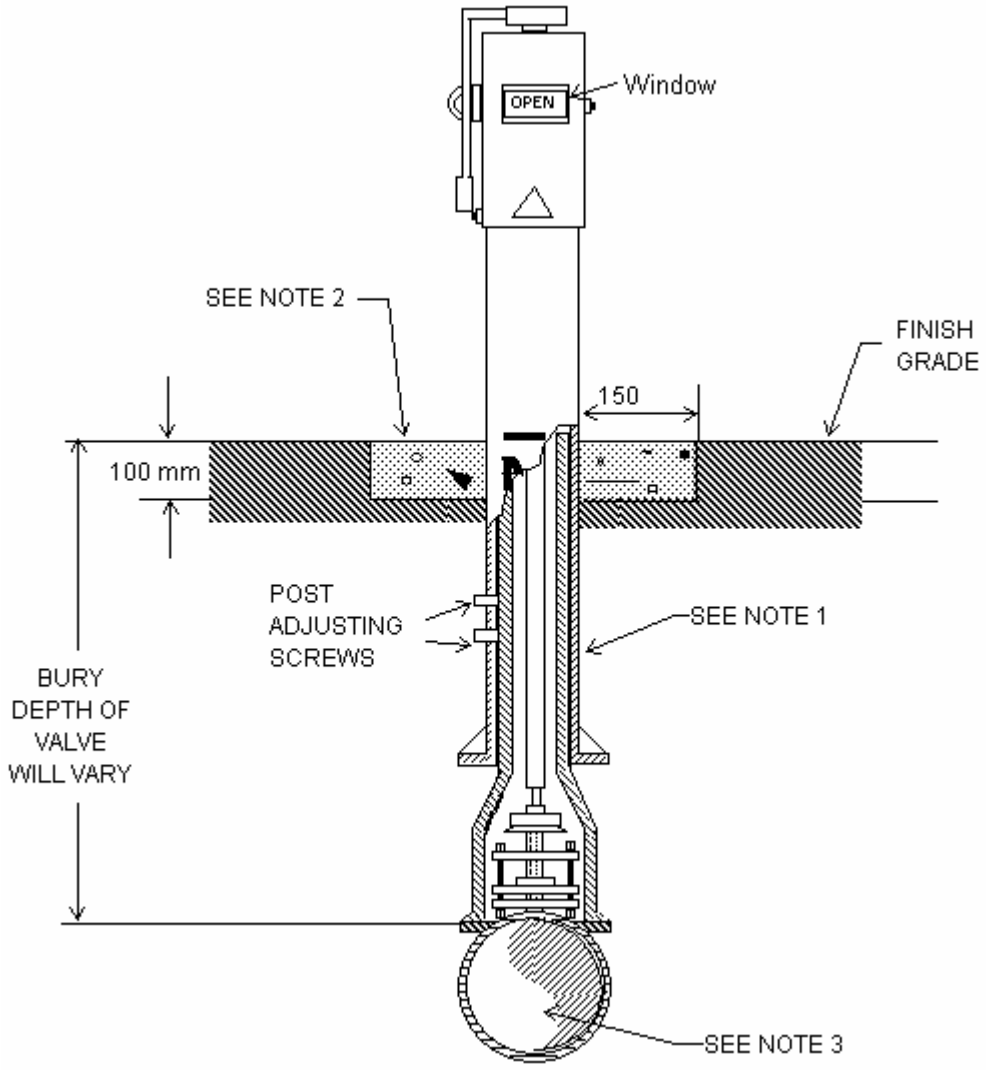


Figure 8 - Direct Buried Valve

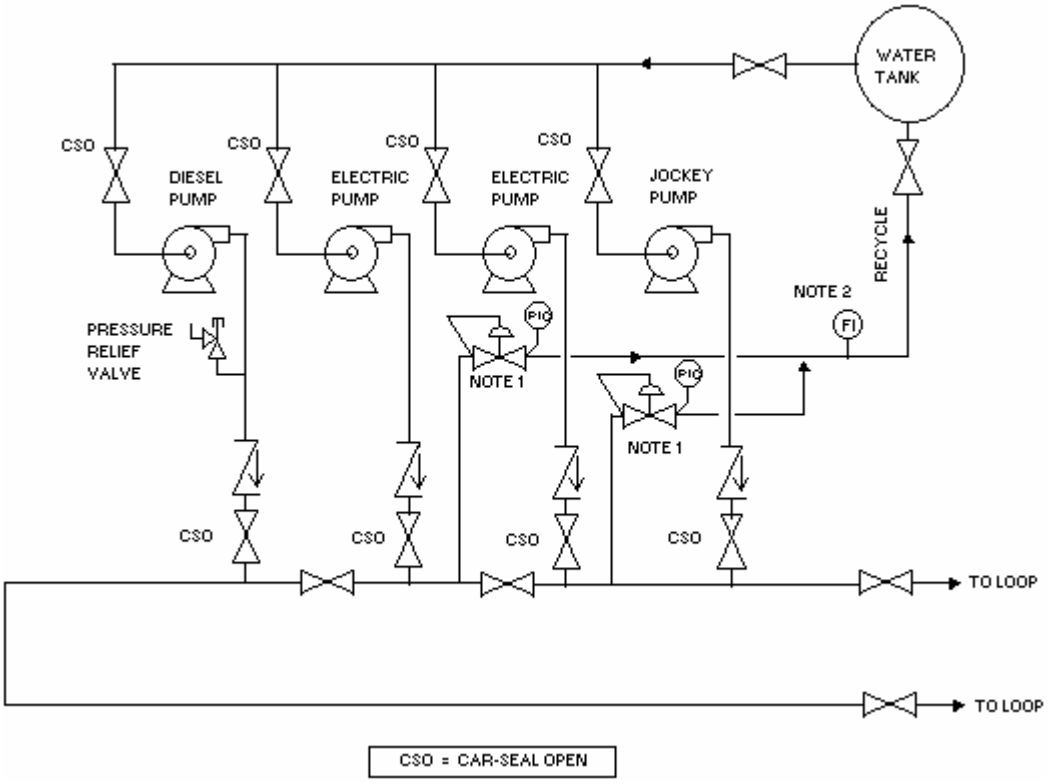
Notes:

(1) Sliding type telescope protective sleeve.

(2) Provide concrete collar if not in a paved area. Round or square configuration is optional.

(3) Direct buried valves shall be non-rising stem post-indicator type with operating nut.

(4) Refer to Section 12.11 for other requirements.



PIC = Indicating Pressure Controller
FI = Indicating Flow Meter

Figure 9 – Fire Pump Piping Manifold, Typical Installation

Notes:

(1) Block valves at pressure control valves are not shown.

(2) Flow indicator location – see Section 12.9.