so one venturi will proportion properly over a wide flow range. The pressure drop through this unit is relatively low. *[See Figure A.3.3.29.2(a).]*

A special test procedure is available to permit the use of a minimum amount of concentrate when the pressure proportioner system is testing.

The pressure proportioning tank has the following limitations:

(1) Foam concentrates with specific gravities similar to water can create a problem when mixed.
(2) The capacity of these proportioners can be varied from approximately 50 percent to 200 percent of their rated capacity.
(3) The pressure drop across the proportioner ranges from 34 kPa to 207 kPa (5 psi to 30 psi), depending on the volume of water flowing within the capacity limits of item (2).
(4) When the concentrate is exhausted, the system must be turned off, and the tank drained of water and refilled with foam concentrate.
(5) Since water enters the tank as the foam concentrate is discharged, the concentrate supply cannot be replenished during operation, as with other methods.
(6) This system proportions at a significantly reduced percentage at low flow rates and should not be used below minimum design flow rate.

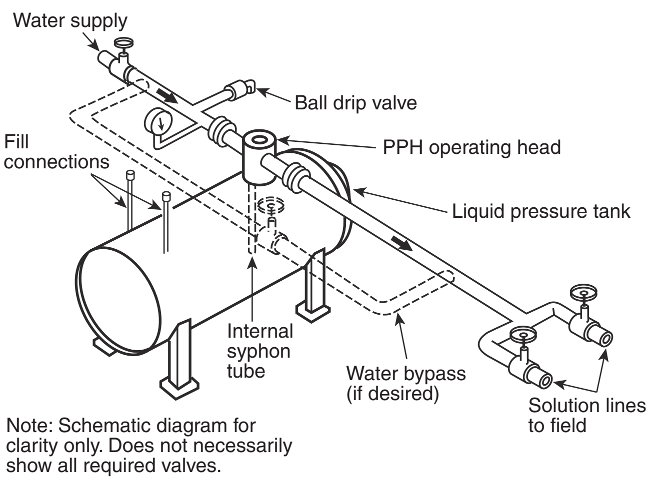

FIGURE A.3.3.29.2(a) Typical Arrangement of Pressure Proportioning Tank.

A diaphragm (bladder) pressure proportioning tank also uses water pressure as a source of power. This device incorporates all the advantages of the pressure proportioning tank with the added advantage of a collapsible diaphragm that physically separates the foam concentrate from the water supply.

Diaphragm pressure proportioning tanks operate through a similar range of water flows and according to the same principles as pressure proportioning tanks. The added design feature is a reinforced elastomeric diaphragm (bladder) that can be used with all concentrates listed for use with that particular diaphragm (bladder) material. *[See Figure A.3.3.29.2(b).]*

The proportioner is a modified venturi device with a foam concentrate feed line from the diaphragm tank connected to the low-pressure area of the venturi. Water under pressure passes through the controller, and part of this flow is diverted into the water feed line to the diaphragm tank. This water pressurizes the tank, forcing the diaphragm filled with foam concentrate to slowly collapse. This forces the foam concentrate out through the foam concentrate feed line and into the low-pressure area of the proportioner controller. The concentrate is metered by use of an orifice or metering valve and mixes in the proper proportion

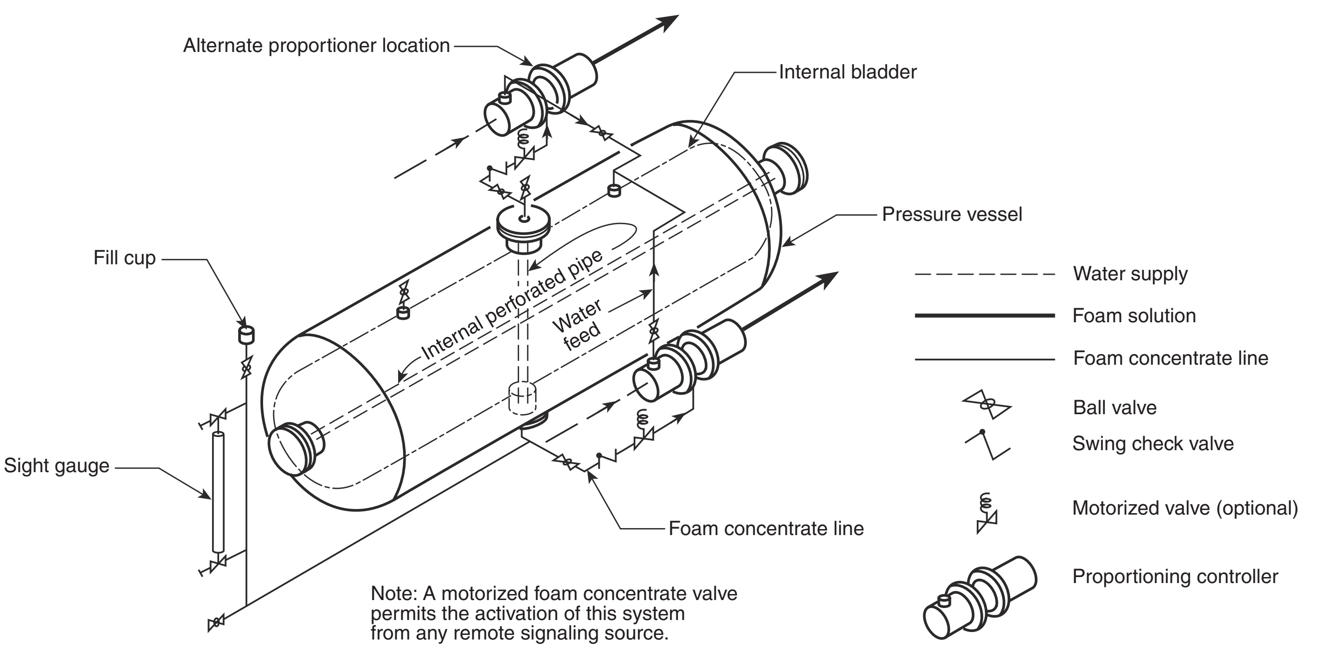

FIGURE A.3.3.29.2(b) Diaphragm (Bladder) Proportioning Tank.

This is a preview. Click here to purchase the full publication.

with the main water supply, sending the correct foam solution downstream to the foam makers.

The limitations are the same as those listed for the pressure proportioning tank, except that the system can be used for all types of concentrates.

A.4.1 A foam system consists of a water supply, a foam concentrate supply, proportioning equipment, a piping system, foam makers, and discharge devices designed to distribute foam effectively over the hazard. Some systems include detection devices.

A.4.1.1 FM Approvals Class 5130, *Approval Standard for Foam Extinguishing Systems*; UL Subject 139, *High-Expansion Foam-Extinguishing System Equipment and Concentrates*; or UL Standard 162, *Standard for Safety Foam Equipment and Liquid Concentrates* should be consulted for possible listing requirements.

A.4.2.1.1.1 Recycled water, processed water, or gray water can be utilized for foam production. When used, a competent evaluation for the suitability of the water quality should be conducted.

A.4.2.1.2 Additional water supplies are recommended for cooling the hot tank shell to assist the foam in sealing against the shell. Some foams are susceptible to breakdown and failure to seal as a result of heating the tank shell due to prolonged burning prior to agent discharge.

A.4.2.1.4 Higher or lower water temperatures can reduce foam efficiency.

A.4.3.1.2 Some concentrates are suitable for use both on hydrocarbon fuels and on water-miscible or polar fuels and solvents.

A.4.3.1.4(4) The method of measurement should be identified, including the device used and parameters such as temperature, spindle number, and spindle speed in revolutions per minute (e.g., Brookfield viscometer).

A.4.3.2.2 The level of concentrate in the storage tank should be monitored to ensure that an adequate supply is available at all times. The hazard requiring the largest foam solution flow rate does not necessarily dictate the total amount of foam concentrate required. For example, a Class II product tank requiring a flow of 1136 L/min (300 gpm) foam solution for 30 minutes would require 1022 L (270 gal) of 3 percent concentrate. A Class I product tank requiring a flow of 946 L/min (250 gpm) foam solution for 55 minutes would require 1563 L (412.5 gal) of 3 percent concentration.

A.4.3.2.3.3 Some foam proportioning systems can have an inherent problem related to loss of foam concentrate and/or damage to bladder tanks or foam pumps if not shut down properly following system activation. There are two scenarios that can occur depending on the proportioning system arrangement. Bladder tank proportioning systems with the water feed line to the bladder tank(s) connected below the foam riser manual shutoff outside screw and yoke (OS&Y) gate valve can be vulnerable depending on the system shutdown procedure followed. When the riser shutoff valve is closed first, foam concentrate continues to flow into the depressurized riser through the proportioner foam metering orifice. If this condition continues, all foam concentrate in the bladder tank will be forced into the riser and foam solution distribution piping. In-line balanced pressure or balanced pressure foam pump-type proportioning systems can also experience a similar loss of foam concentrate depending on the system installation arrangement. If the water supply (riser OS&Y) valve is located before (upstream) the foam proportioner with the foam pump still running, the same potential for foam concentrate loss exists. When the water supply (riser OS&Y) valve is closed, the foam proportioner is no longer pressurized and foam concentrate will be forced through the proportioner and metering orifice into the riser. If allowed to continue, this condition will deplete the foam tank and possibly cause harm to the foam pump by running in a "dry" condition. Close the foam concentrate supply valve before shutting off the water supply valve, to prevent loss of concentrate. In the case of a pump-type system, it will allow foam to recirculate back to the foam tank until the foam pump is shut off. Alternatively, in the case of bladder tank systems, the water feed valve to the tank(s) could be closed, which would stop the foam injection process.

A.4.3.2.4.1 Since such systems might or might not be operated for long periods after installation, the choice of proper storage conditions and maintenance methods largely determines the reliability and the degree of excellence of system operation when they are put into service.

A.4.3.2.4.2 Foam concentrates are subject to freezing and to deterioration from prolonged storage at high temperatures. The storage temperature should be monitored to ensure that listed temperature limitations are not exceeded. Concentrates can be stored in the containers in which they are transported or can be transferred into large bulk storage tanks, depending on the requirements of the system. The location of stored containers requires special consideration to protect against exterior deterioration due to rusting or other causes. Bulk storage containers also require special design consideration to minimize the liquid surface in contact with air.

A.4.4.1.1 Often, different brands of the same type of foam concentrates are found to be chemically compatible. However, before different brands of concentrates are mixed for long-term storage, evaluations should be made to determine such compatibility. A number of parameters should be considered and evaluated before concentrates are mixed for storage. In addition to the chemical compatibility, one should consider effects on proportioning and discharge hardware (many listings and approvals are very specific with regard to operating pressures, flow ranges, and materials of construction of hardware components). The application method should be the same for both foams being mixed. The system design application rate (density) might have to be changed if one of the foam concentrates being admixed is listed or approved at an application rate (density) that is higher than the one used for the initial design. This generally applies to alcohol-resistant foams since their listings and approvals are very application rate sensitive.

A.4.4.2 Some expanded foam is not compatible with all dry chemical agents.

A.4.5.1 Some alcohol-resistant foam proportioners require much higher flow rates to meet the minimum flow and proper proportioning percentage of the foam concentrate being used. In balanced pressure systems when the flow is less than the listed minimum, the foam percentage is less than the required where a smaller proportioner should be applied or an in-line balanced pressure proportioning system should be used when the flow rate is below the minimum listed flow rate the percentage is greater than the design percentage of the foam concentrate.

A.4.6 Foam concentrate pumps are generally of the positive displacement variety. Centrifugal pumps might not be

This is a preview. Click here to purchase the full publication.

suitable for use with foam concentrates exhibiting high-viscosity characteristics. The foam equipment manufacturer should be consulted for guidance.

A.4.7.1 This section addresses the pipe section that contains foam concentrate from the foam concentrate storage tank to the side inlet of the proportioner or eductor.

A.4.7.1.1 Some fluoroprotein from concentrates are incompatible with stainless steel pipe. Check with the manufacturer of the foam concentrate to ensure compatibility of the foam concentrate pipe material.

A.4.7.1.2 Carbon steel pipe has been used fro concentrate pipe. Some foam concentrates, in particular alcohol-resistant foam concentrates, are corrosive to the carbon steel pipe and could deteriorate the integrity of the pipe. Carbon steel pipe is also susceptible to oxidation when air is present in the pipe.

A.4.7.1.7 Additional pressure may be required to start flow from a static condition. The friction losses associated with large pipe networks may have a significant impact.

A.4.7.2 This section address the pipe section(s) that contains foam solution located from the flow-through outlet of the foam concentrate proportioner or eductor to the discharge device.

A.4.7.2.1 Most deluge type foam water systems are subject to harsh environmental conditions, which can subject the foam solution feed line piping to internal to external corrosion. Types of systems that fall into this category include open head sprinklers, foam spray nozzles, monitors, foam chambers, fixed foam makers, fixed medium expansion foam makers, and high expansion foam systems. These systems are typically utilized for protection of fuel storage tanks, diked fuel containment areas, LNG facilities, truck and rail car loading racks, aircraft hangars, warehouses, marine docs, interior fuel storage tanks, refineries and manufacturing/processing areas.

The foam solution piping on these systems is exposed to thermal changes, air movement, and other environmental conditions that can cause condensation, and the resulting corrosion can lead to the formation of debris and pipe scale. This material can inhibit proper function of the foam system discharge devices due to blockage. To alleviate the problem of foam systems with piping that is normally open to the surrounding atmosphere, these types of systems are to be constructed using pipe fitting materials identified in 4.7.2.1 and 4.7.3.2.1. Corrosive atmospheres could require other coatings.

A.4.7.3.1 Corrosive atmospheres could require other coatings.

A.4.7.4.3 Welding is preferable where it can be done without introducing fire hazards.

A.4.7.6 A hazard area generally includes all areas within dikes and within 15 m (50 ft) of tanks without dikes. Other areas that should be considered hazard areas include the following:

(1) Locations more than 15 m (50 ft) from tanks without dikes, if the ground slope allows exposure from accidentally released flammable and combustible liquids
(2) Extensive manifold areas where flammable and combustible liquids might be released accidentally
(3) Other similar areas

The presence of flammable and combustible liquids within pipelines that do not possess the potential to release flammable and combustible liquids should not be considered as creating a hazard area. Ball valves can be used for foam concentrate proportioning systems.

A.4.9.2.5 See applicable sections of *NFPA 72*.

A.4.9.2.6 See Article 500 and other articles in Chapter 5 of *NFPA 70*.

A.5.1 There have been cases reported where the application of foam through solid streams that were plunged into the flammable liquid has been believed to be the source of ignition of the ensuing fire. The ignitions have been attributed to static discharges resulting from splashing and turbulence. Therefore, any application of foam to an unignited flammable liquid should be as gentle as possible. Correct application methods with portable equipment might include a spray pattern or banking the foam stream off a backboard so that the foam flows gently onto the liquid surface. Also, correctly designed fixed foam chambers on tanks could be expected to deliver the foam fairly gently and not cause a problem. Covered (internal) floating roof tanks can experience two distinct types of fires: a full surface area fire (as a result of the floating roof sinking) or a seal fire. There have been few fires in double-deck or pontoon-type floating roof tanks where fixed roofs and venting are designed in accordance with NFPA 30. Prior to selecting the method of protection, the type of fire that will serve as the basis for design should be defined.

Outdoor Fixed-Roof (Cone) Tanks. Within the scope of this standard, fixed-roof (cone) tanks are defined as vertical cylindrical tanks with a fixed roof designed as a conical section, and they comply with the requirements set forth in NFPA 30. Typically, these tanks have a weak seam at the junction of the vertical side and roof. In the event of an internal explosion, the seam usually parts and the roof blows off, leaving the shell intact to retain the tank contents. The resulting fire involves the entire exposed surface of the product.

These systems are used for the protection of outdoor process and storage tanks. They include the protection of such hazards in manufacturing plants as well as in large tank farms, oil refineries, and chemical plants. These systems usually are designed for manual operation but, in whole or in part, can be automatic in operation. Foam systems are the preferred protection for large outdoor tanks of flammable liquids, as shown in Figure A.5.1.

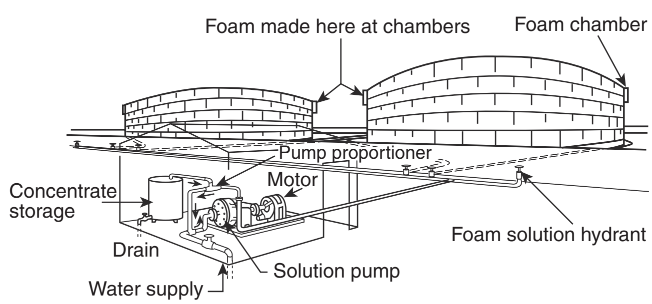

FIGURE A.5.1 Schematic Arrangement of Air Foam Protection for Storage Tanks.

A.5.2.3 The requirements provided in this section are based on extrapolations of test experience and appropriate listings and reflect the limitations known to date. Foam can fail to seal against the tank shell as a result of prolonged free burning prior to agent discharge. If adequate water supplies are available, cooling of the tank shell is recommended. Where the entire liquid surface has been involved, fires in tanks up to 39 m (150 ft) in diameter have been extinguished with large-capacity foam monitors. Depending on the fixed-roof tank outage and fire intensity, the updraft

This is a preview. Click here to purchase the full publication.

due to chimney effect can prevent sufficient foam from reaching the burning liquid surface to form a blanket. Foam should be applied continuously and evenly. Preferably, it should be directed against the inner tank shell so that it flows gently onto the burning liquid surface without undue submergence. This can be difficult to accomplish, as adverse winds, depending on velocity and direction, reduce the effectiveness of the foam stream. Fires in fixed-roof tanks with ruptured roofs that have only limited access for foam application are not easily extinguished by monitor application from ground level. Fixed foam monitors can be installed for protection of drum storage areas or diked areas.

A.5.2.4.2.1 The specified minimum delivery rate for primary protection is based on the assumption that all the foam reaches the area being protected.

A.5.2.4.2.2 Where protection is desired for hydrocarbons having a flash point above 93.3°C (200°F), a minimum discharge time of 35 minutes should be used.

A.5.2.4.3 When some older types of alcohol-resistant foam concentrate are used, consideration should be given to solution transit time. Solution transit time (i.e., the elapsed time between injection of the foam concentrate into the water and the induction of air) might be limited, depending on the characteristics of the foam concentrate, the water temperature, and the nature of the hazard protected. The maximum solution transit time of each specific installation should be within the limits established by the manufacturer.

A.5.2.4.3.1 In general, alcohol-resistant foams can be effectively applied through foam monitor or foam hose streams to spill fires of these liquids where the liquid depth does not exceed 25.4 mm (1 in.).

A.5.2.4.3.2 If application results in foam submergence, the performance of alcohol-resistant foams usually deteriorates significantly, particularly where there is a substantial depth of fuel. The degree of performance deterioration depends on the degree of water solubility of the fuel (i.e., the more soluble, the greater the deterioration).

A.5.2.5.1 For this application, discharge outlets are commonly called foam chambers. Most foam chambers are of a Type II discharge outlet design, since they are normally suitable for use with modern foams.

A.5.2.5.2.1 It is recommended that, for tanks greater than 60 m (200 ft) in diameter, at least one additional discharge outlet should be added for each additional 465 m^2 (5000 ft^2) of liquid surface or fractional part thereof. Since there has been limited experience with foam application to fires in fixed-roof tanks greater than 42 m (140 ft) in diameter, requirements for foam protection on such tanks are based on the extrapolation of data from successful extinguishments in smaller tanks. Tests have shown that foam can travel effectively across at least 30 m (100 ft) of burning liquid surface. On fixed-roof tanks of over 60 m (200 ft) diameter, subsurface injection can be used to reduce foam travel distances for tanks containing hydrocarbons only. Unless subsurface foam injection is utilized, a properly sized flanged connection should be installed on all atmospheric pressure storage tanks, regardless of present intended service, to facilitate the future installation of an approved discharge outlet if a change in service should require such installation. Figure A.5.2.5.2.1(a) and Figure A.5.2.5.2.1(b) are typical fixed foam discharge outlets or foam chambers.

A.5.2.5.2.2 Type I discharge outlets are considered obsolete, and Type I outlets that are damaged effectively become Type II outlets. Minimum discharge times and application rates for Type I outlets currently installed are provided in Table 5.2.5.2.2 for fixed-roof tanks storing hydrocarbons and in Table 5.2.5.3.4 for flammable and combustible liquids requiring alcohol-resistant foams.

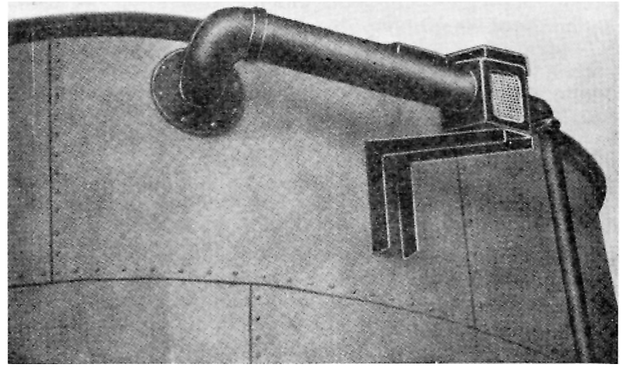

FIGURE A.5.2.5.2.1(a) Air Foam Maker in Horizontal Position at Top of Storage Tank.

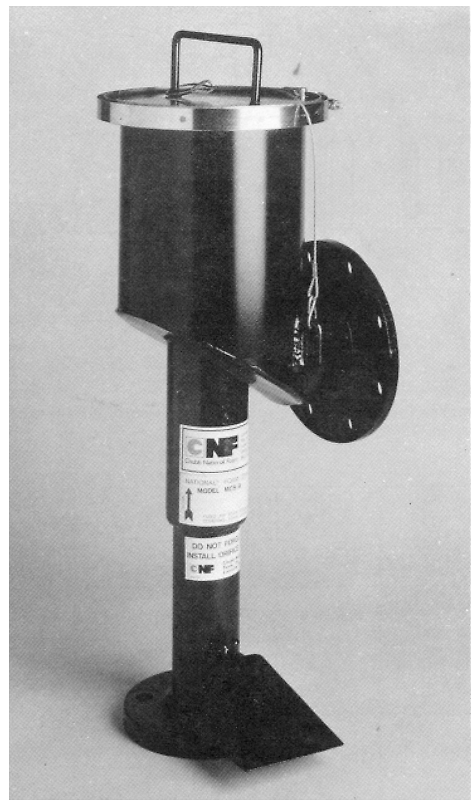

FIGURE A.5.2.5.2.1(b) Foam Chamber and Foam Maker.

A.5.2.5.3 The system should be designed based on fighting a fire in one tank at a time. The rate of application for which the system is designed should be the rate computed for the protected tank considering both the liquid surface area and the type of flammable liquid stored. For example, the property contains a 12.2 m (40 ft) diameter tank storing ethyl alcohol and 10.7 m (35 ft) diameter tank storing isopropyl ether. The

This is a preview. Click here to purchase the full publication.

liquid surface area of a 12.2 m (40 ft) diameter tank equals 116.8 m^2 (1257 ft^2). Assuming the solution rate for ethyl alcohol is 4.1 L/min·m^2 (0.1 gpm/ft^2), then 1257 gpm/ft^2 × 0.1 = 477 L/min (126 gpm). The liquid surface area of a 10.7 m (35 ft) diameter tank equals 89.4 m^2 (962 ft^2).

Assuming the solution rate for isopropyl ether is 6.1 L/min·m^2 (0.15 gpm/ ft^2), then 962 ft^2 × 0.15 gpm/ft^2 = 144 gpm. For SI units: Solution rate = 89.4 × 6.1 = 545 L/min. In this example, the smaller tanks storing the more volatile product require the higher foam-generating capacity. In applying this requirement, due consideration should be given to the future possibility of change to a more hazardous service requiring greater rates of application. Unfinished solvents or those of technical grade can contain quantities of impurities or diluents. The proper rate of application for these, as well as for mixed solvents, should be selected with due regard to the foam-breaking properties of the mixture.

A.5.2.5.3.2 Systems using these foams require special engineering consideration.

A.5.2.6.1 Experience with fuel storage tank fire fighting has shown that the main problems are operational (i.e., difficulty in delivering the foam relatively gently to the fuel surface at an application rate sufficient to effect extinguishment). A properly engineered and installed subsurface foam system offers the potential advantages of less chance for foam-generation equipment disruption as a result of an initial tank explosion or the presence of fire surrounding the tank, and the ability to conduct operations a safe distance from the tank. Thus, the opportunity for establishing and maintaining an adequate foam application rate is enhanced. The following guidelines regarding fire attack are recommended. After necessary suction connections are made to the water supply and foam-maker connections are made to foam lines, foam pumping operations should be initiated simultaneously with opening of block valves permitting the start of foam flow to the tank. Solution pressure should be brought up to and maintained at design pressure.

When foam first reaches the burning liquid surface, there can be a momentary increase in intensity caused by the mechanical action of steam formation when the first foam contacts the heat of the fire. Initial flame reduction and reduction of heat is then usually quite rapid, and gradual reduction in flame height and intensity will occur as the foam closes in against the tank shell and over the turbulent areas over foam injection points. If sufficient water supplies are available, cooling of the tank shell at and above the liquid level will enhance extinguishment and should be used. Care should be taken that water streams are not directed into the tank where they could disrupt the established foam blanket. After the fire has been substantially extinguished by the foam, some fire can remain over the point of injection. With flash points below 37.8°C (100°F) (Class IB and Class IC liquids), the fire over the turbulent area will continue until it is adequately covered by foam. With gasoline or equivalent liquids, when fire remains only over the area of injection, intermittent injection should be used so that foam will retrogress over the area during the time foam injection is stopped. Depending on local circumstances, it might be possible to extinguish any residual flickers over the turbulent area with portable equipment rather than continue the relatively high rate of application to the whole tank. If the tank contains a burning liquid capable of forming a heat wave, a slop-over can occur from either topside or subsurface injection of foam, especially if the tank has been burning for 10 minutes or longer. Slop-over can be controlled by intermittent foam injection or reduction in foam-maker inlet pressure until slop-over ceases. Once slop-over has subsided, and in the case of liquids that do not form a heat wave, the pump rate should be continuous. Figure A.5.2.6.1(a) and Figure A.5.2.6.1(b) illustrate typical arrangements of semifixed subsurface systems.

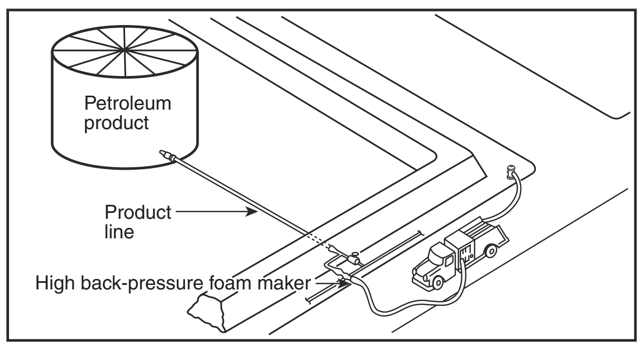

FIGURE A.5.2.6.1(a) Semifixed Subsurface Foam Installation.

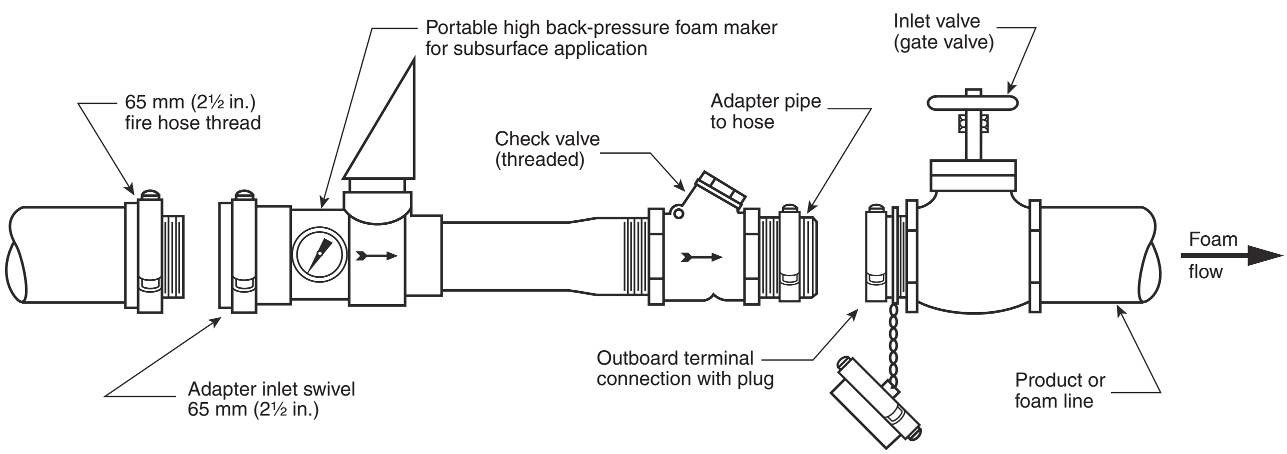

FIGURE A.5.2.6.1(b) Typical Connection for Portable High Back-Pressure Foam Maker for Subsurface Application in Semifixed System.

This is a preview. Click here to purchase the full publication.

A.5.2.6.2 Figure A.5.2.6.2(a) through Figure A.5.2.6.2(c) should be used to determine foam velocity.

Expanded foam velocity also can be calculated by using the following formulas:

[A.5.2.6.2a]

$$\text{English velocity (ft/sec)} = \frac{\text{Expanded foam (gpm)}}{KA}$$

where:

gpm = gallons per minute

K = constant 449

A = area of ID of the injection pipe (ft^2)

or

$$V = \frac{\text{gpm foam}}{d^2} \quad 0.4085 \qquad \textbf{[A.5.2.6.2b]}$$

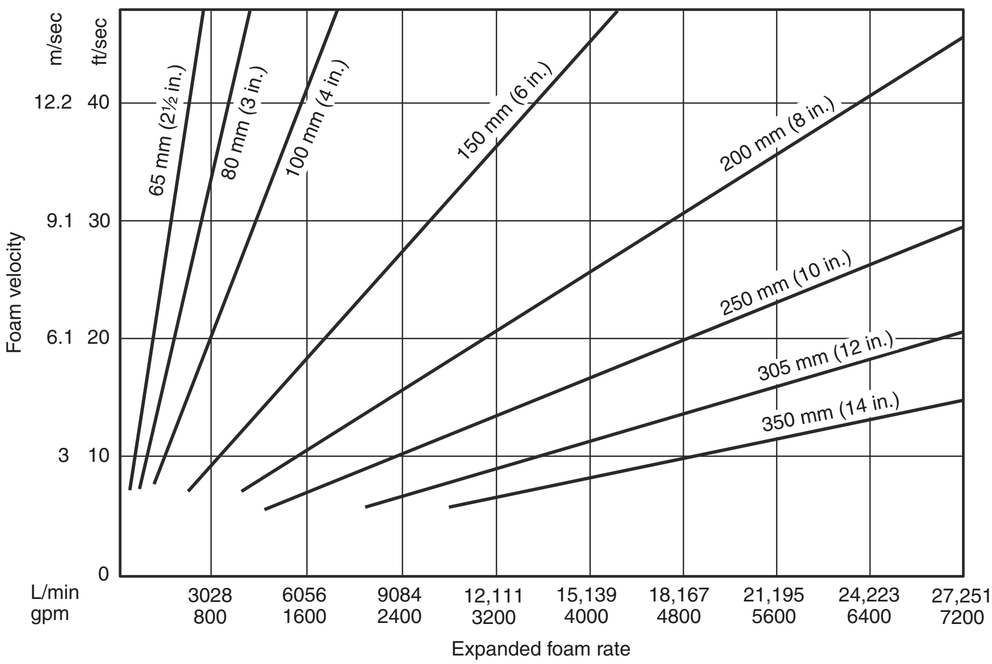

FIGURE A.5.2.6.2(a) Foam Velocity vs. Pipe Size (2½ in., 3 in., 4 in., 6 in., 8 in., 10 in., 12 in., and 14 in.) — Standard Schedule 40 Pipe.

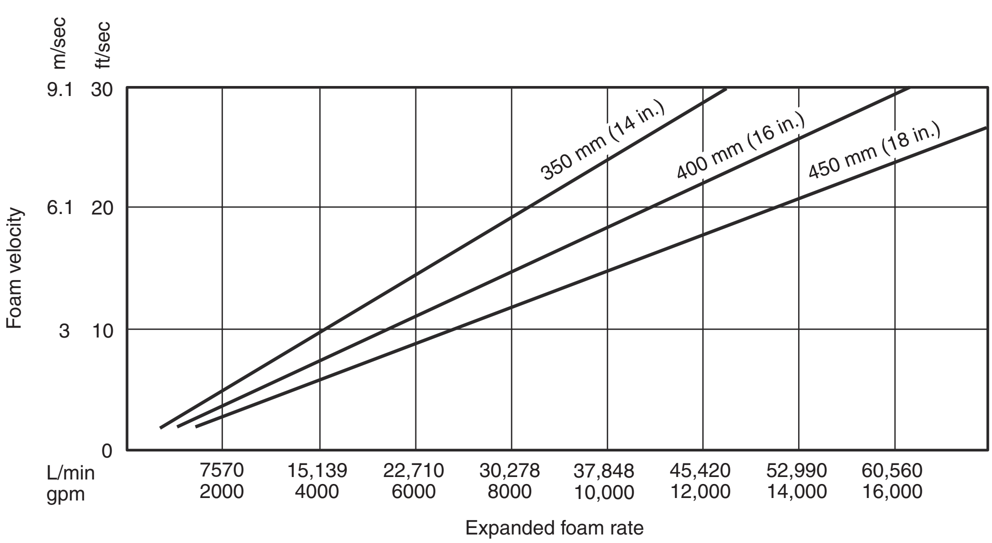

FIGURE A.5.2.6.2(b) Foam Velocity vs. Pipe Size (14 in., 16 in., and 18 in.)— Standard Schedule 40 Pipe.

This is a preview. Click here to purchase the full publication.

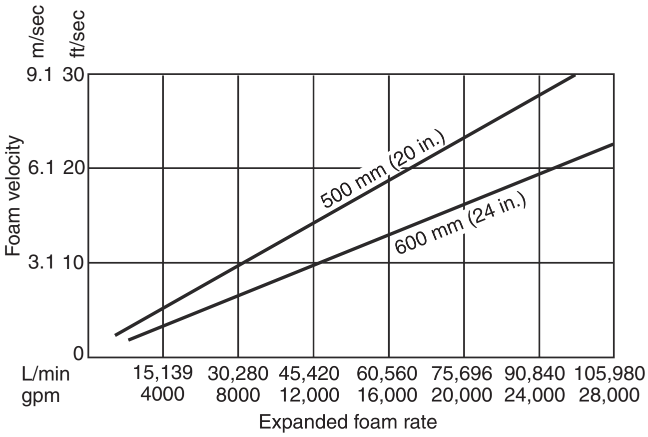

FIGURE A.5.2.6.2(c) Foam Velocity vs. Pipe Size (20 in. and 24 in.) — Standard Schedule 40 Pipe.

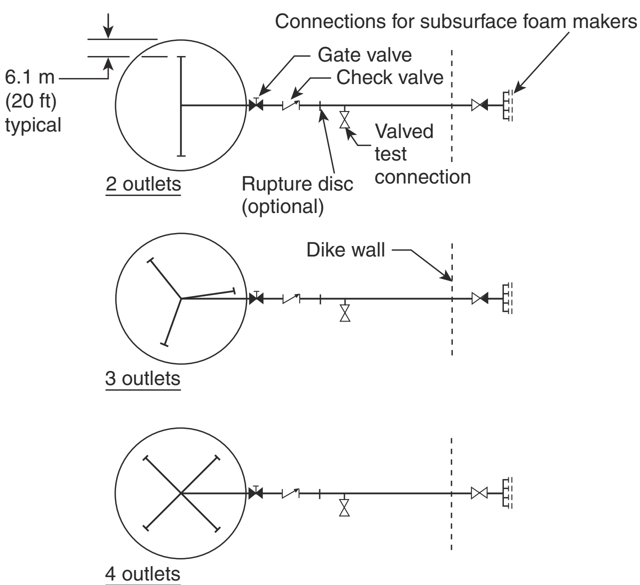

FIGURE A.5.2.6.2(d) Typical Arrangement of Semifixed Subsurface System.

where:
d = pipe ID (in.)

[A.5.2.6.2c]

$$\text{Metric velocity (m/sec)} = \frac{\text{L/min foam}}{d^2} \quad 21.22$$

where:
d = pipe ID (mm)

Figure A.5.2.6.2(d) illustrates optional arrangements for multiple subsurface discharge outlets.

A.5.2.6.3 Figure A.5.2.6.3 illustrates a typical foam inlet tank connection.

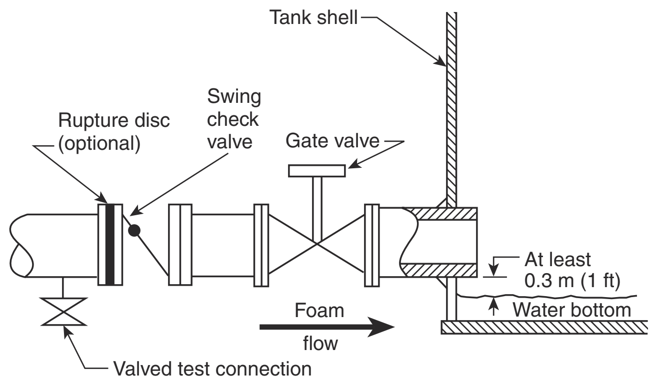

FIGURE A.5.2.6.3 Typical Tank Foam-Maker Discharge Connection for Subsurface Injection.

A.5.2.6.3.1 Liquid hydrocarbons that contain foam-destructive products might require higher application rates. Some foams might fail to extinguish fires in gasolines containing oxygenates where subsurface discharge is used at the usually required rate. Optimum fluoroprotein foam, AFFF, and FFFP characteristics for subsurface injection purposes should have expansion ratios between 2 and 4. *[See Figure A.5.2.6.3.1(a) and Figure A.5.2.6.3.1(b).]*

A.5.2.6.4 The back pressure consists of the static head plus pipe friction losses between the foam maker and the foam inlet to the tank. The friction loss curves, as shown in Figure A.5.2.6.4(a) and Figure A.5.2.6.4(b), are based on a maximum foam expansion of 4, which is the value to be used for friction loss and inlet velocity calculations.

A.5.2.6.5.2 Liquid hydrocarbons that contain foam-destructive products might require higher application rates. Some foams might fail to extinguish fires in gasolines containing oxygenates where subsurface discharge is used at the usually required rate.

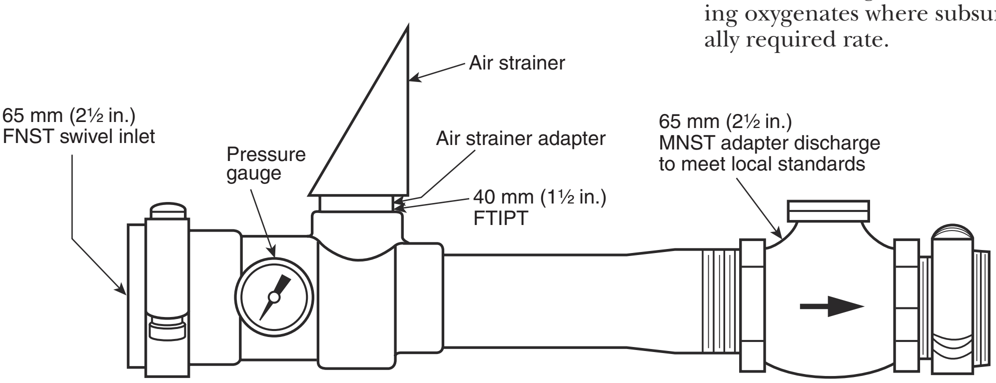

FIGURE A.5.2.6.3.1(a) Portable High Back-Pressure Foam Maker for Semifixed Systems.

This is a preview. Click here to purchase the full publication.

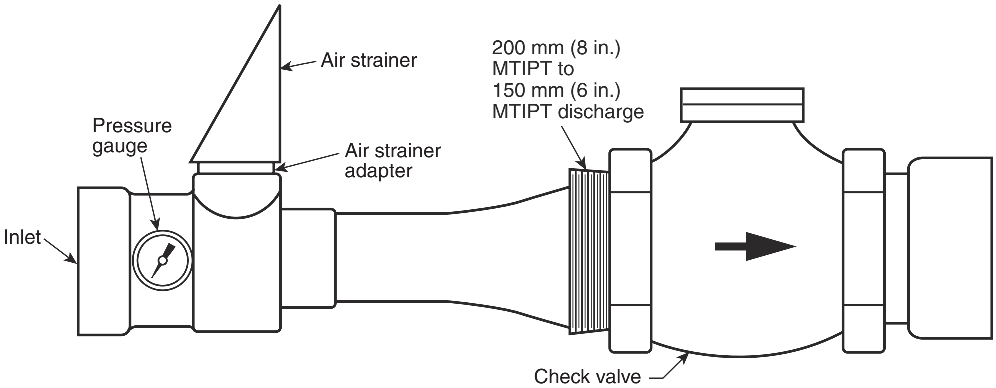

FIGURE A.5.2.6.3.1(b) Fixed High Back-Pressure Foam Maker for Fixed Systems.

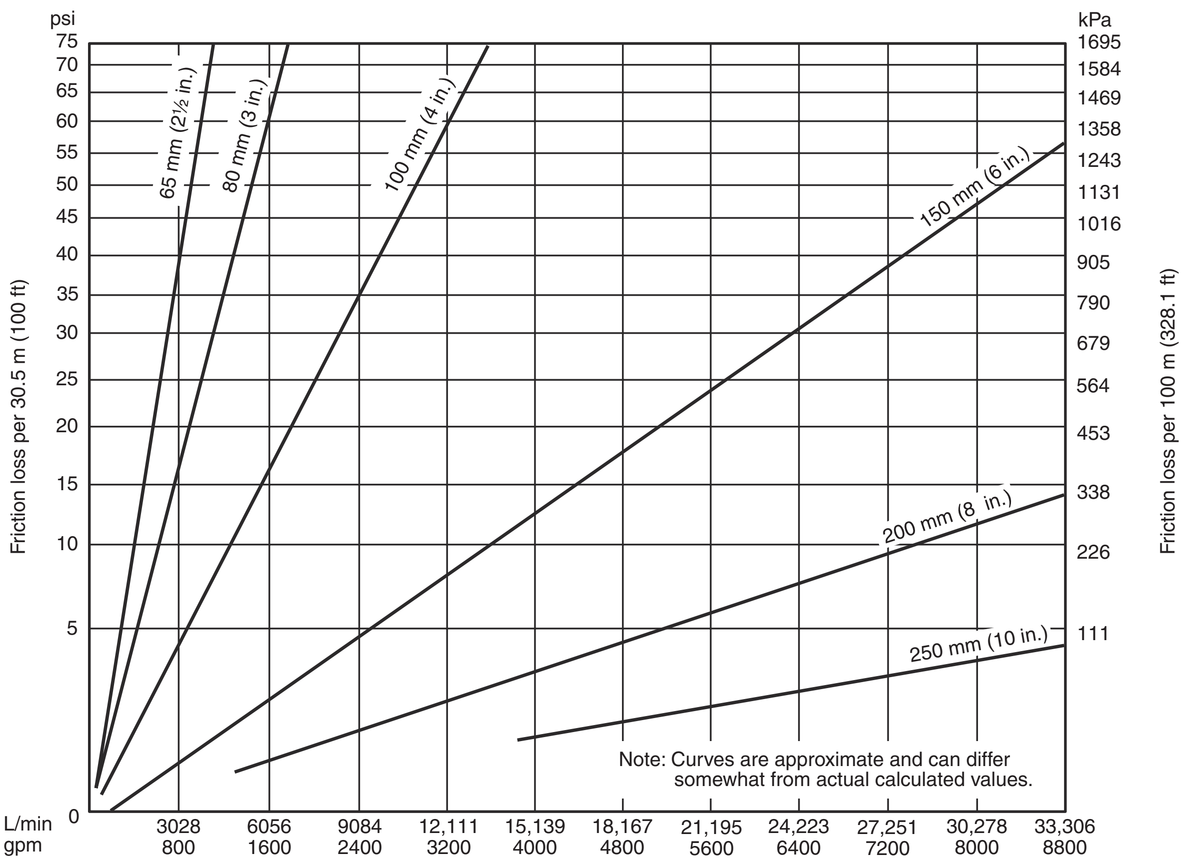

FIGURE A.5.2.6.4(a) Foam Friction Losses — 4 Expansion (2½ in., 3 in., 4 in., 6 in., 8 in., and 10 in.) — Standard Schedule 40 Pipe.

A.5.2.7 This section describes the design criteria that are applicable to systems used to apply foam to the surface of fixed-roof (cone) storage tanks via a flexible hose rising from the base of the tank. Manufacturer recommendations should be followed for the design and installation of such systems. For semisubsurface system arrangement, see Figure A.5.2.7.

These systems are not considered appropriate for floating roof tanks with or without a fixed roof because the floating roof prevents foam distribution. The flexible foam delivery hose is contained initially in a sealed housing and is connected to an external foam generator capable of working against the maximum product head. When operated, the hose is released from its housing, and the hose floats to the surface as a result of the buoyancy of the foam. Foam then discharges through the open end of the hose directly onto the liquid surface.

Consideration should be given to the following factors when selecting this type of system:

This is a preview. Click here to purchase the full publication.

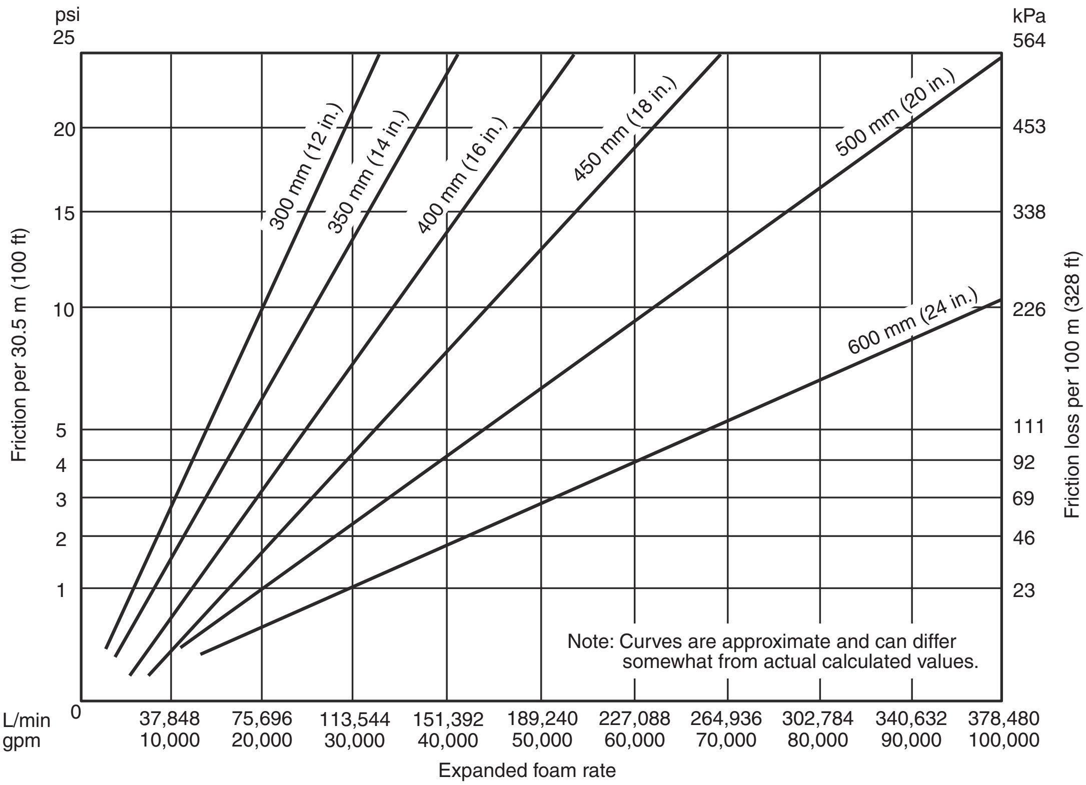

FIGURE A.5.2.6.4(b) Foam Friction Losses — 4 Expansion (12 in., 14 in., 16 in., 18 in., 20 in., and 24 in.) — Standard Schedule 40 Pipe.

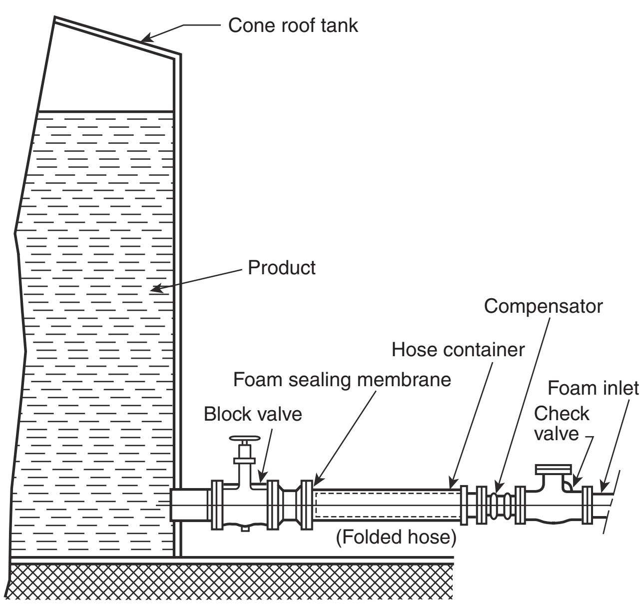

FIGURE A.5.2.7 Semisubsurface System Arrangement.

(1) The total foam output should reach the surface of the burning liquid.
(2) With large tanks, the semisubsurface units can be arranged to produce an even distribution over the fuel surface.
(3) Any type of concentrate suitable for gentle surface application to the particular fuel can be used.
(4) Foam-generating equipment and operating personnel can be located at a distance from the fire.
(5) The system can be used for the protection of foam destructive liquids, provided the flexible hose is not affected by them.
(6) Certain high-viscosity fuels might not be suitable for protection by this type of system.
(7) There is no circulation of the cold fuel and, therefore, no assistance in extinguishment.
(8) The system can be difficult to check, test, and maintain.
(9) The high back-pressure foam generator has to produce foam at a pressure sufficient to overcome the head pressure of fuel as well as all friction losses in the foam pipework. Friction losses with foam differ from those with foam solution.

Design application rates and discharge times for hydrocarbons are typically the same as for Type II topside application systems [i.e., 4.1 L/min·m^2 (0.1 gpm/ft^2)]. Manufacturers should be consulted for appropriate application rates and design recommendations to be followed for protection of products requiring the use of alcohol-resistant foams.

Duration of discharge should be in accordance with Table A.5.2.7(a).

This is a preview. Click here to purchase the full publication.

Table A.5.2.7(a) Duration of Discharge for Semisubsurface Systems

Product Stored Foam	Type Minimum	Discharge Time (minutes)
Hydrocarbons with flash point below 37.8°C (100°F)	Protein, AFFF, fluoroprotein, FFFP, and alcohol-resistant AFFF or FFFP	55
Flash point at or above 37.8°C (100°F)	All foams	30
Liquids requiring alcohol-resistant foams	Alcohol-resistant foams	55

Semisubsurface foam units should be spaced equally, and the number of units should be in accordance with Table A.5.2.7(b).

A.5.3 Within the scope of this standard, open-top floating roof tanks are defined as vertical cylindrical tanks without fixed roofs that have double-deck or pontoon-type floating roofs and are constructed in accordance with the requirements of NFPA 30. The seal can be a mechanical shoe seal or tube seal. The tube seal can be equipped with a metal weather shield. Secondary seals of combustible or noncombustible materials can also be installed. *[See Figure 5.3(a) through Figure 5.3(d).]*

A.5.3.3 Open-top floating roof tanks can be subject to two distinct types of fires: a seal fire or a full surface area fire (as a result of the floating roof sinking). Experience indicates that the most frequent type of fire involves only the seal of the floating roof tank. Prior to selection of the method of protection, the type of fire that will serve as the basis for design should be defined. *(See NFPA 30 for fire protection requirements.)*

Most fires in open-top floating roof tanks occur in the seal areas, and these fires can be extinguished with the foam systems described in Chapter 5. However, some fires involve the full surface area when the roof sinks. These fires are very infrequent and normally do not justify a fixed system to protect for this risk. Plans should be made to fight a full surface fire in a floating roof tank with portable or mobile equipment. Large capacity foam monitor nozzles with capacities up to 22,712 L/min (6000 gpm) are currently available. If foam-proportioning devices are not provided with the foam monitors, additional foam-proportioning trucks might be required through mutual aid. Generally, the number of foam-proportioning trucks available at any location is not sufficient to fight a sunken floating roof fire, and outside assistance is required.

Table A.5.2.7(b) Minimum Number of Subsurface Units

Tank Diameter m	Tank Diameter ft	Minimum Number of Semisubsurface Units
Up to 24	Up to 80	1
Over 24 to 36	Over 80 to 120	2
Over 36 to 42	Over 120 to 140	3
Over 42 to 48	Over 140 to 160	4
Over 48 to 54	Over 160 to 180	5
Over 54 to 60	Over 180 to 200	6
Over 60	Over 200	6 Plus 1 outlet for each additional 465 m^2 (5000 ft^2)

Generally, the fire water systems available in floating roof tank areas are not designed to fight a full surface fire, so additional water is required. Therefore, relay pumping with municipal or mutual aid water pumpers might be required to obtain enough water for foam generation.

Another aspect to consider is the amount of foam concentrate available. The foam application rate of 6.5 L/min·m^2 (0.16 gpm/ft^2) of surface area listed in Chapter 5 might have to be increased for very large tanks. Therefore, the amount of foam concentrate available through mutual aid should be established prior to the fire. In some cases, it can be necessary to increase the on-site foam storage if mutual aid supplies are limited.

If it is decided to fight a fire in a tank with a sunken roof instead of protecting the adjacent facilities and allowing a controlled burnout, the most important aspect is to have planned ahead and held simulated drills. Coordinating the efforts of many different organizations and various pumping operations required for fighting potentially catastrophic fires requires well-developed plans and plenty of practice.

A.5.3.4.3 The requirements given in this section are based on extrapolations of test experience and appropriate listings and reflect the limitations known to date. Foam can fail to seal against the tank shell as a result of prolonged free burning prior to agent discharge. If adequate water supplies are available, cooling of the tank shell is recommended.

A.5.3.5.2 See Figure A.5.3.5.2(a) and Figure A.5.3.5.2(b).

A.5.3.5.2.3 Since all the discharge outlets are supplied from a common (ring) foam solution main, some vapor seal devices might not rupture due to pressure variations encountered as the system is activated. *[See Figure A.5.3.5.2(a) and Figure A.5.3.5.2(b).]*

A.5.3.5.4.5 Excessive dam openings for drainage should be prohibited to prevent loss of foam through the drainage slots.

A.5.3.6 Use of foam handlines for the extinguishment of seal fires should be limited to open-top floating roof tanks of less than 76.2 m (250 ft) in diameter. The following design information applies to foam handline protection methods:

(1) A foam dam should be installed in accordance with 5.3.5.4.
(2) To establish a safe base for operation at the top of the tank, a single fixed foam discharge outlet should be installed at the top of the stairs. This fixed foam discharge outlet is supplied to provide coverage of the seal area for approximately 12.2 m (40 ft) on both sides of the top of the stairs.
(3) The fixed foam discharge outlet should be designed to discharge at least 189.3 L/min (50 gpm).
(4) To permit use of foam handlines from the windgirder, two 38.1 mm (1.5 in.) diameter valved hose connections should be provided at the top of the stairs in accordance with Figure A.5.3.6. The windgirder should be provided with a railing for the safety of the fire fighters.

This is a preview. Click here to purchase the full publication.