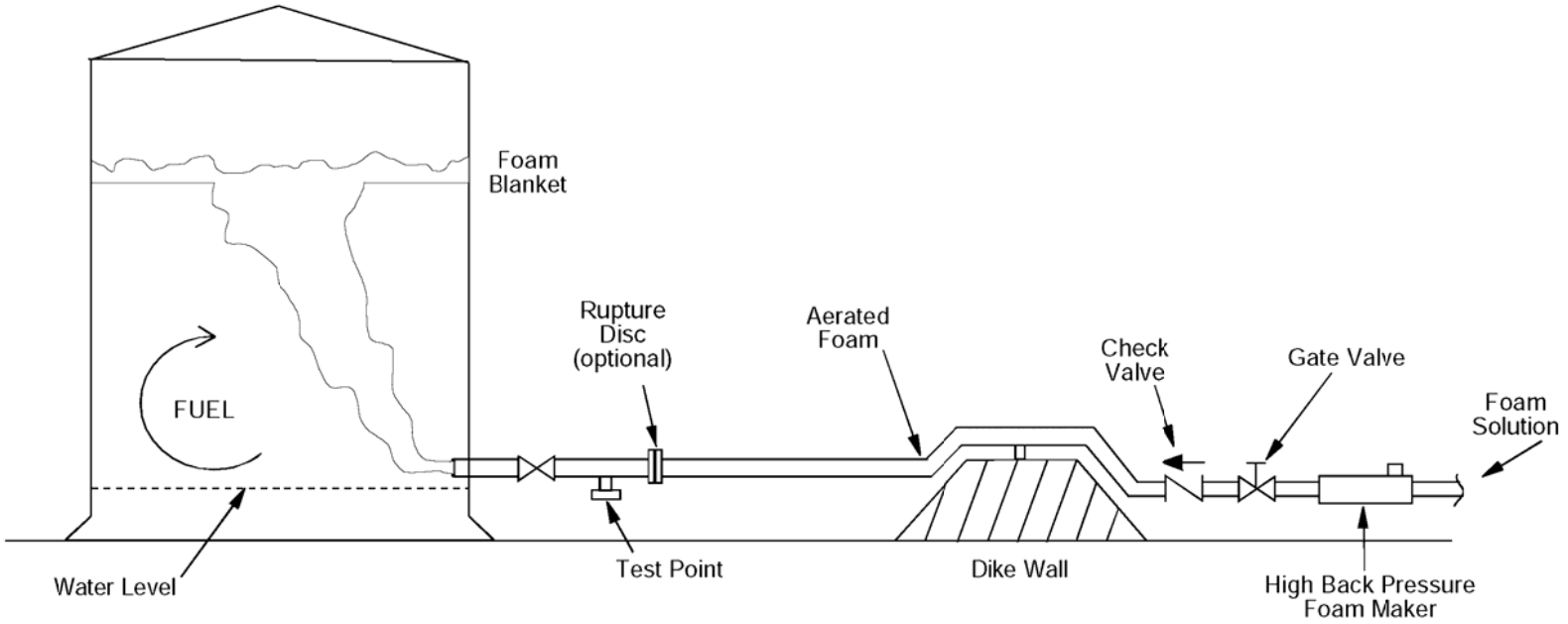
SUB-SURFACE INJECTION APPLICATION ON CONE ROOF TANK



D003rv995

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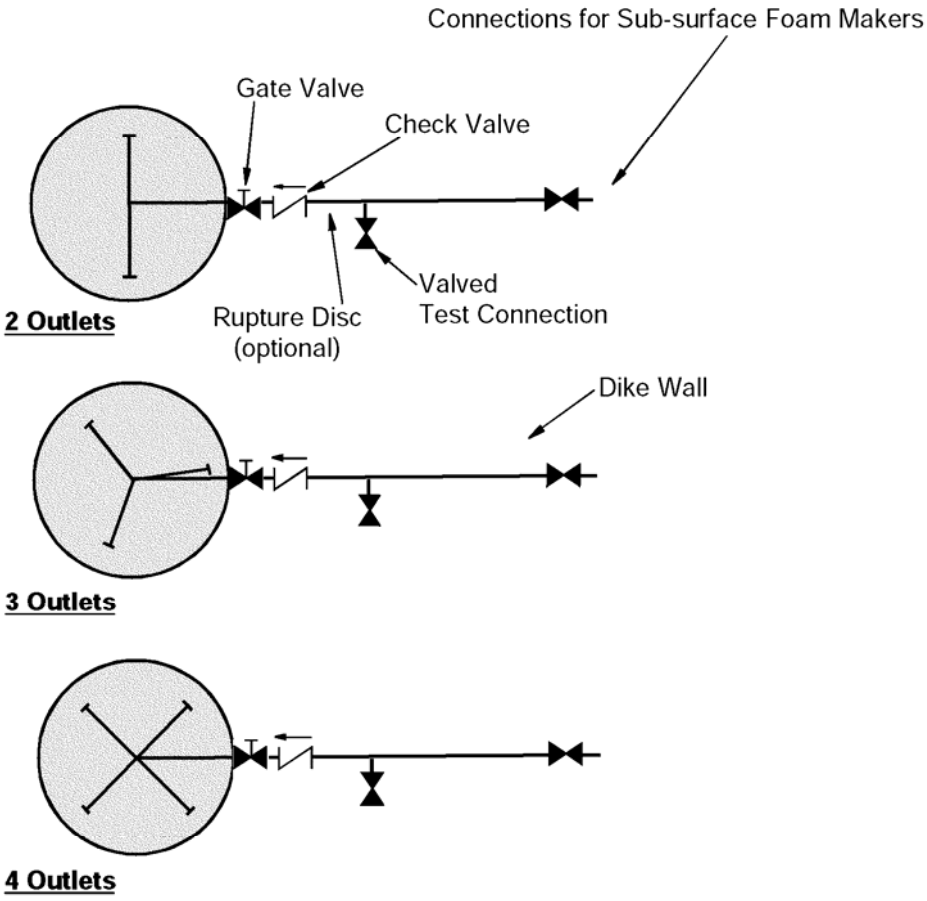
TYPICAL OUTLETS FOR SUB-SURFACE INJECTION INSIDE CONE ROOF STORAGE TANKS



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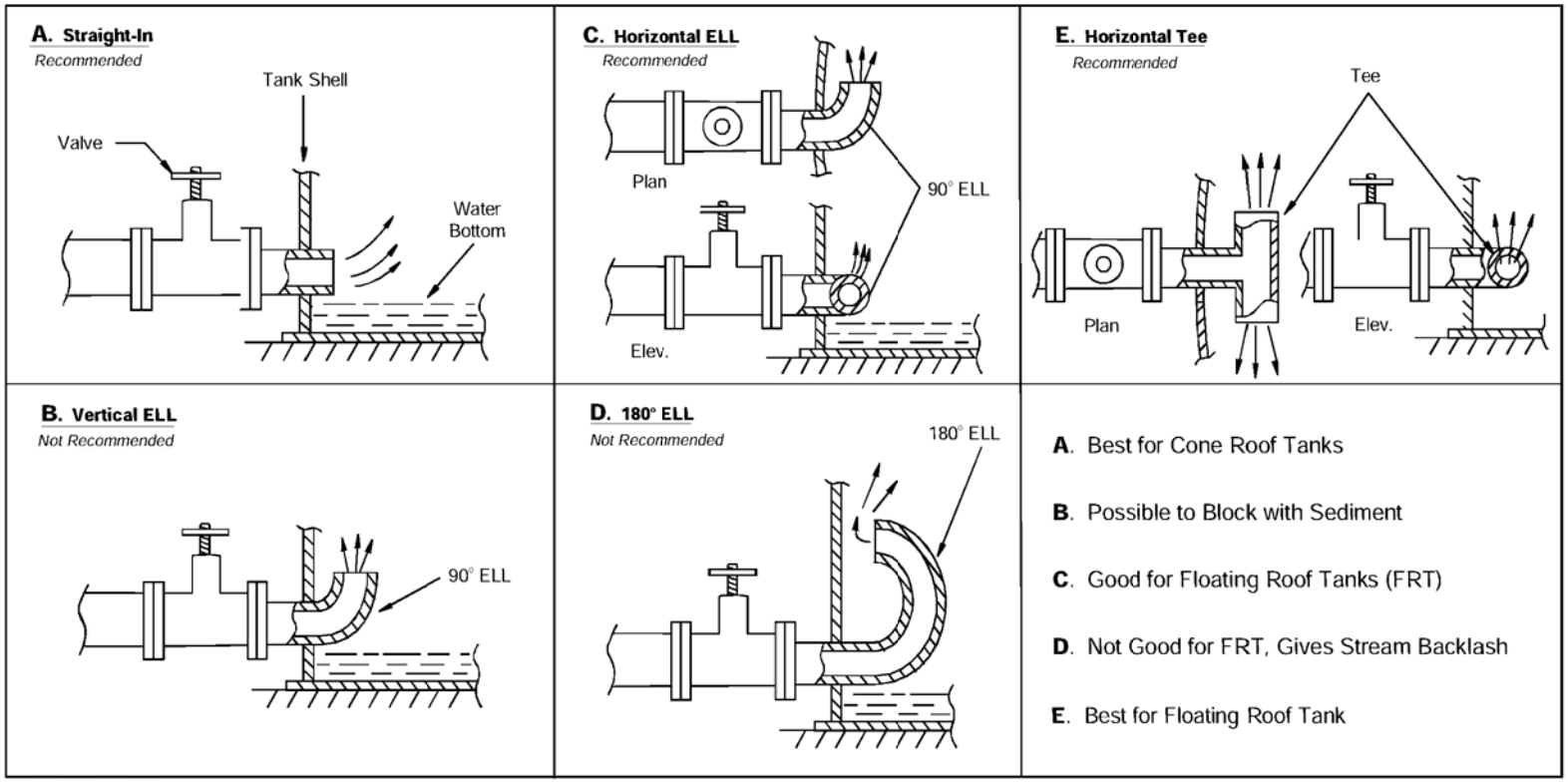
TYPICAL SUB-SURFACE TANK PROTECTION INLET DESIGN



D019rv195

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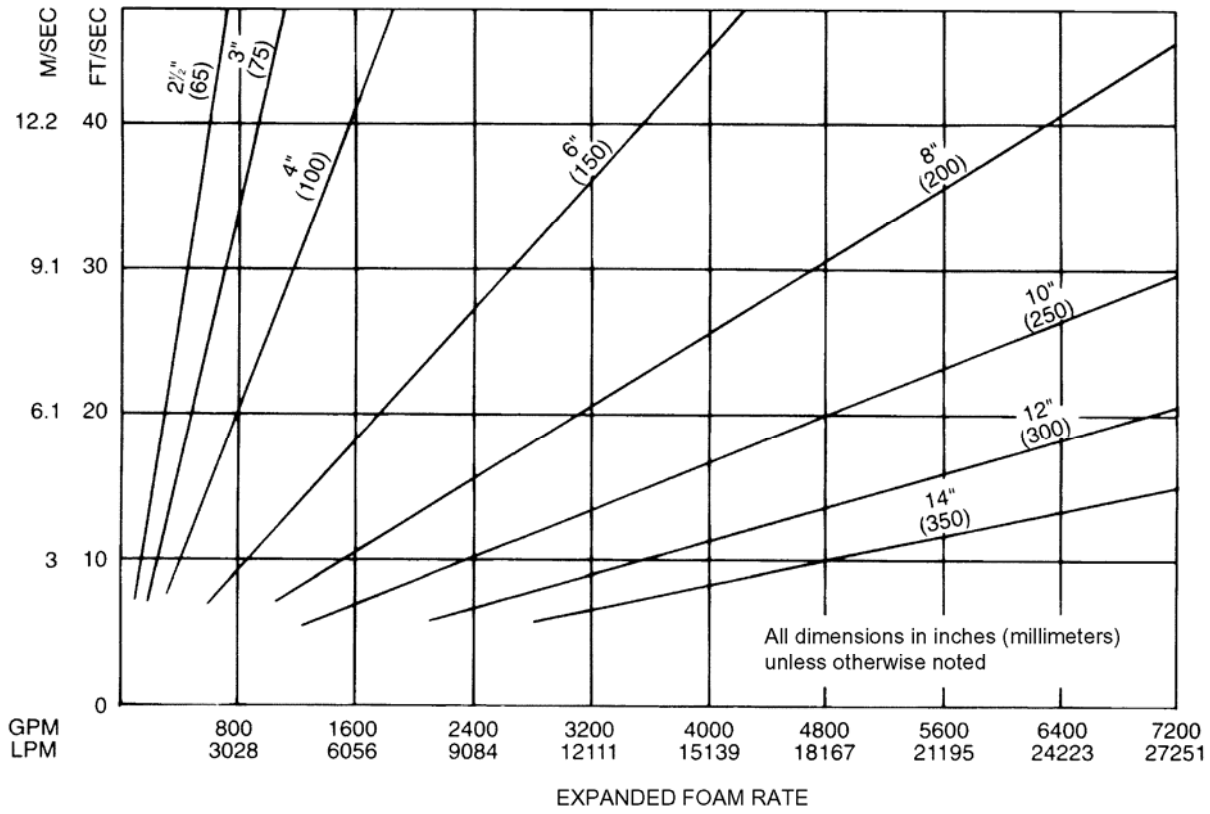
EXPANDED FOAM VELOCITY vs PIPE SIZE

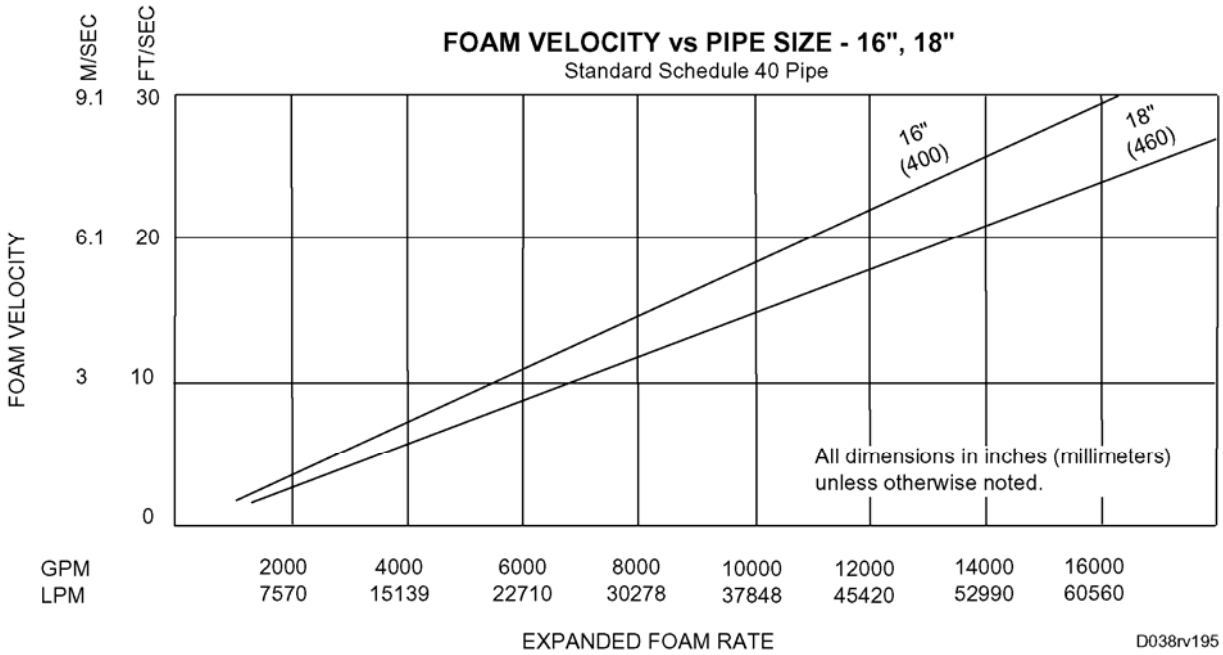
2 1/2", 3", 4", 6", 8", 10", 12", 14"

Standard Schedule 40 Pipe



FOAM VELOCITY vs PIPE SIZE - 16", 18"

Standard Schedule 40 Pipe



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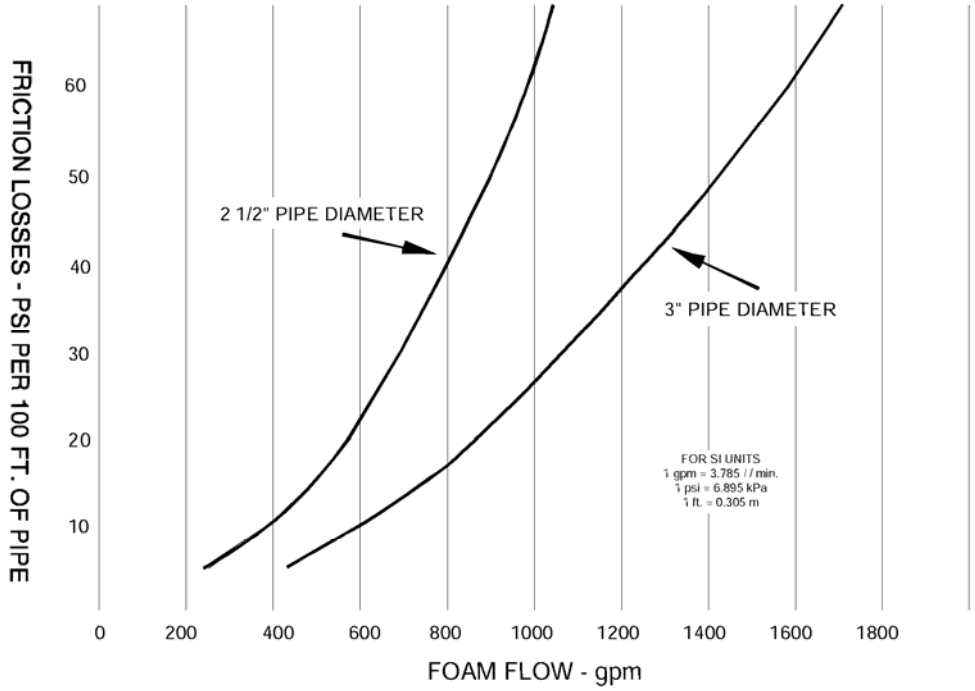
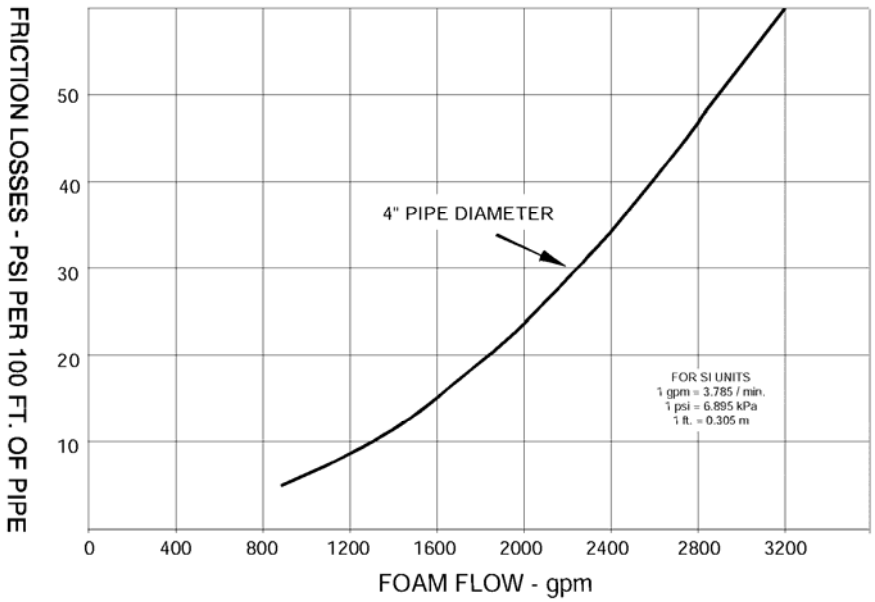
FRICTION LOSS OF EXPANDED FOAM THROUGH VARIOUS SIZE PIPES

These subsurface graphs depict the friction loss characteristics of foam with an expansion of 4 to 1 and inlet velocities for various pipe sizes. The 4 to 1 ratio is the value to be used for friction loss and inlet velocity calculations.





D075rv195

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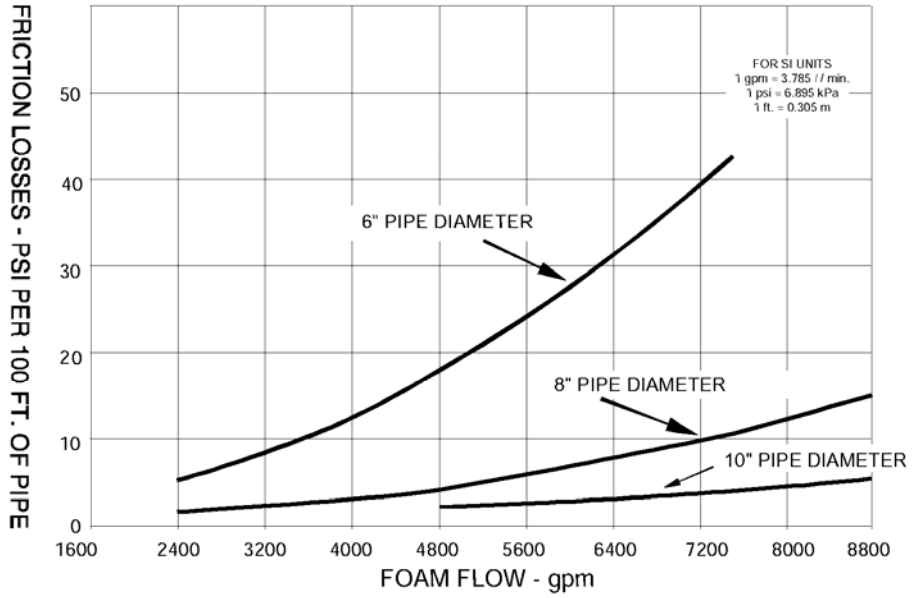

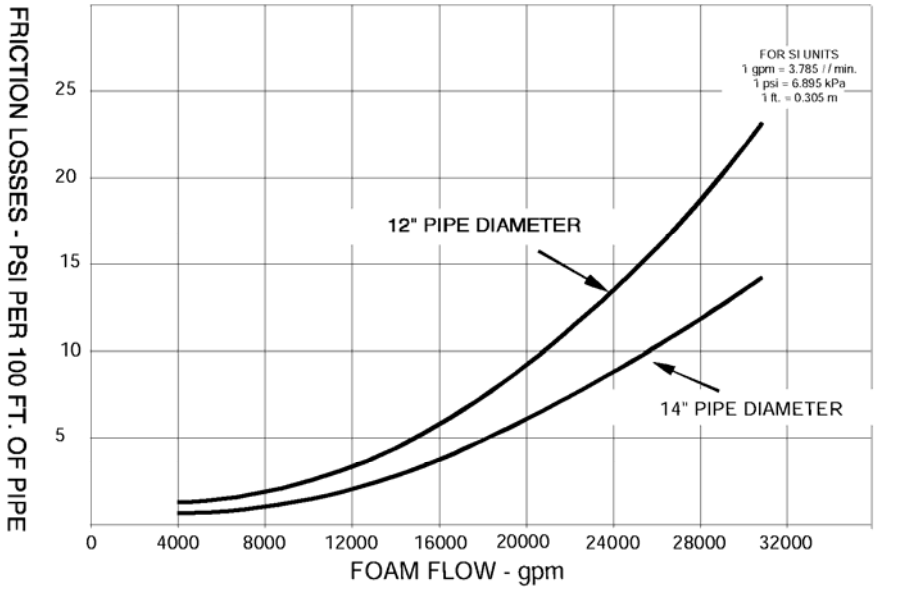

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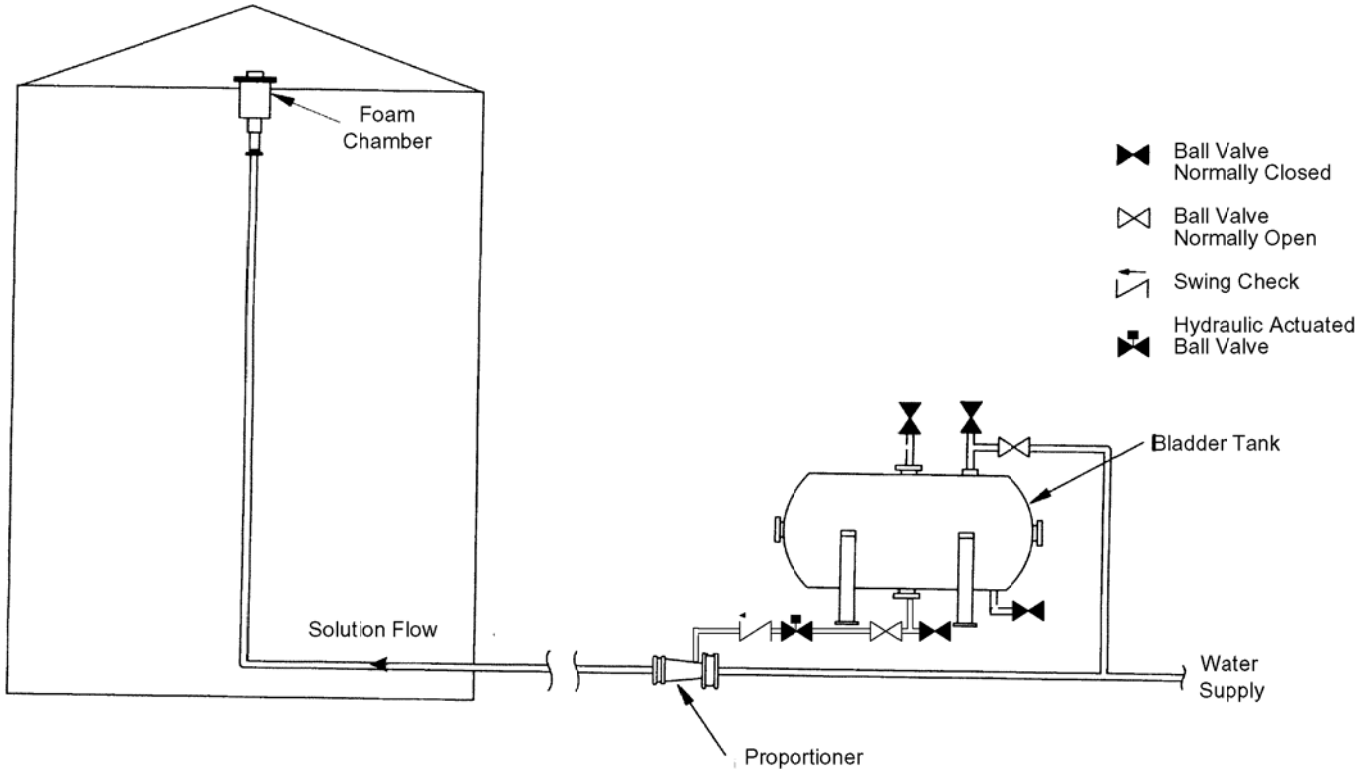
FOAM CHAMBER INSTALLATION
FIXED SYSTEM USING A BLADDER TANK



D010rv1296

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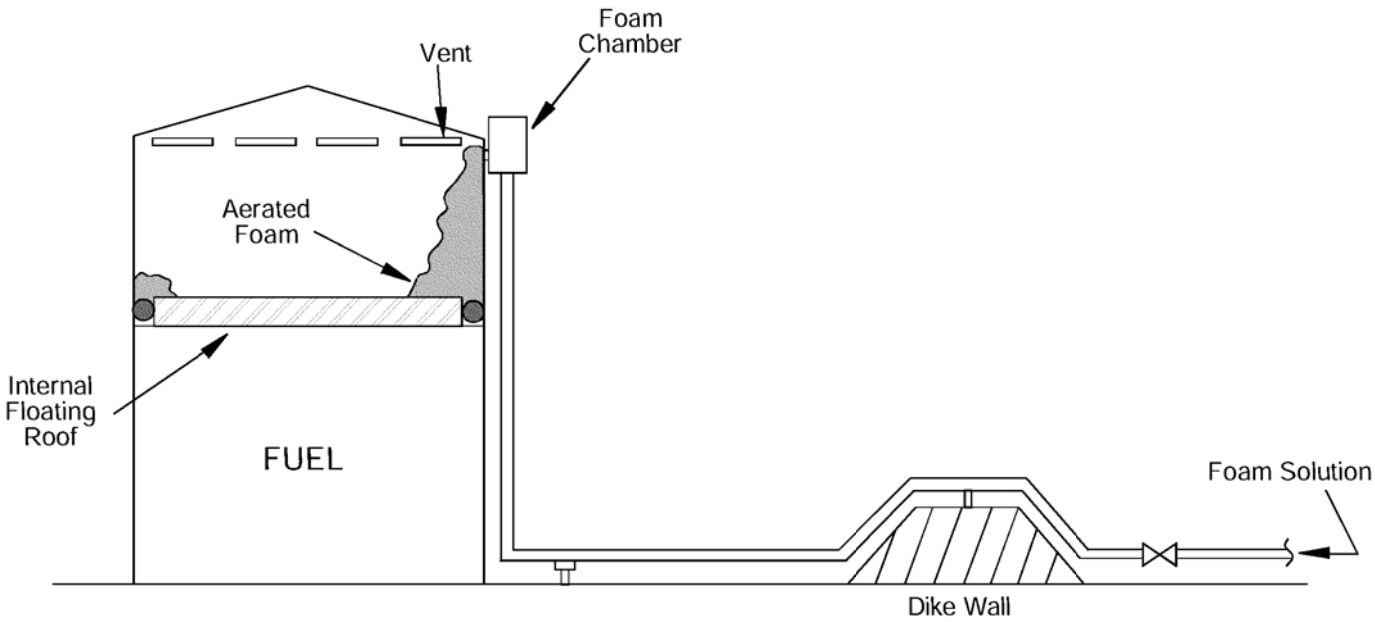
FOAM CHAMBER TOPSIDE APPLICATION ON INTERNAL FLOATING ROOF TANK



D003rv195

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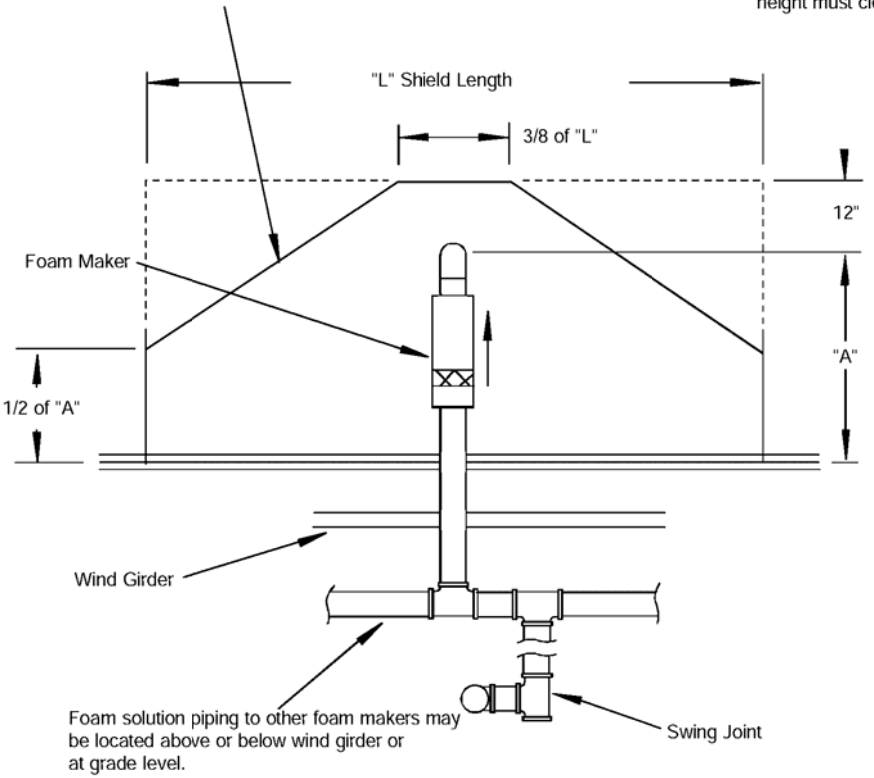
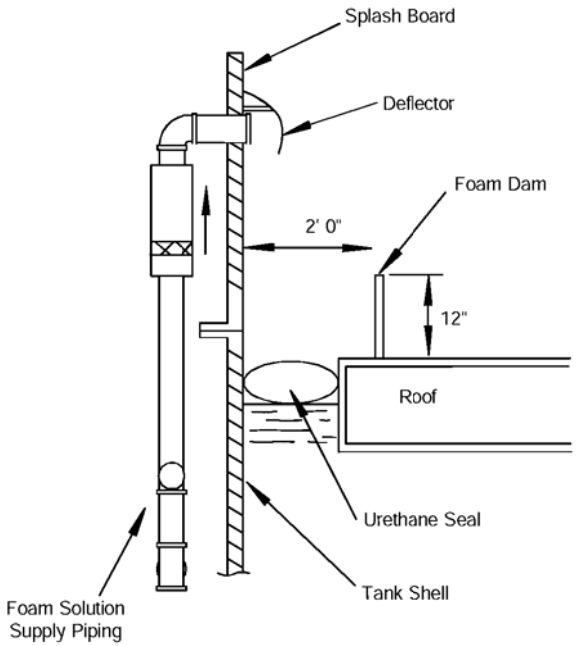
INSTALLATION OF FOAM MAKER & SPLASH BOARD ON FLOATING ROOF TANKS

Sheet steel splash board can be rectangular or cut as shown mounted on top of shell reinforced with suitable supports. Minimum dimensions will depend on minimum clearance needed between foam discharge outlet and top position of roof.

"A" Dimension is the height of the foam maker outlet above the top edge of the tank shell. The minimum height must clear the top position of the floating roof.





D040rv195

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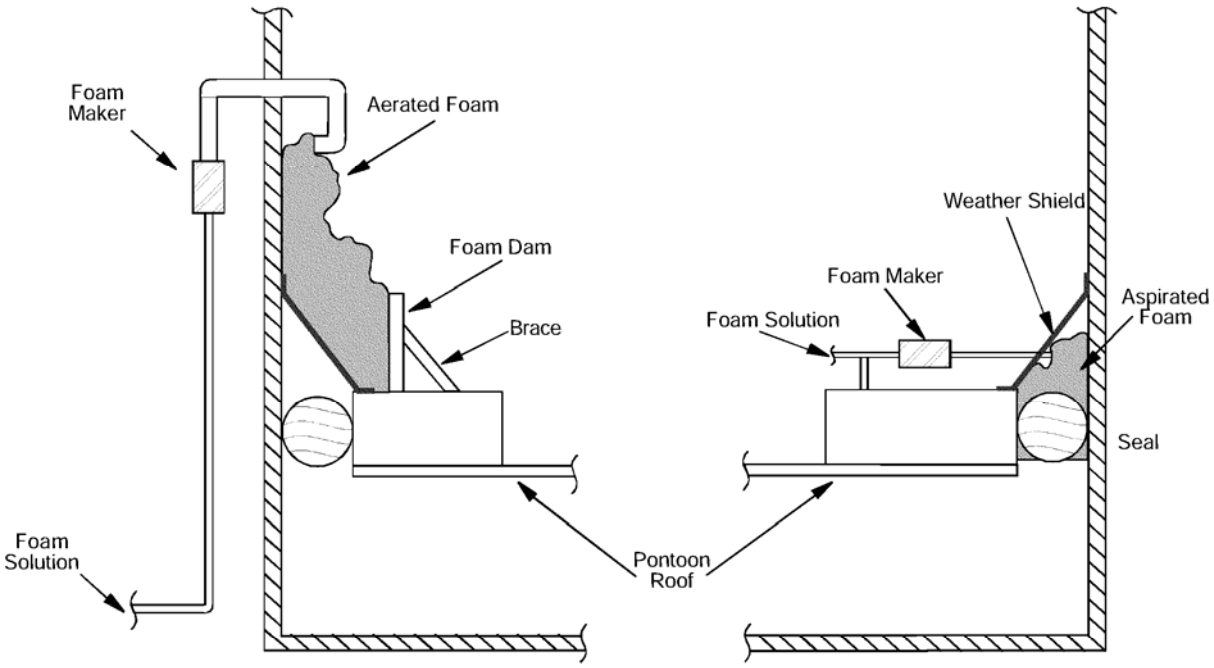
EXAMPLES OF TYPICAL TOP AND BELOW SEAL APPLICATIONS FOR FLOATING ROOF TANKS



Typical Top of Seal Application

Typical Below Seal Application

D005rv195

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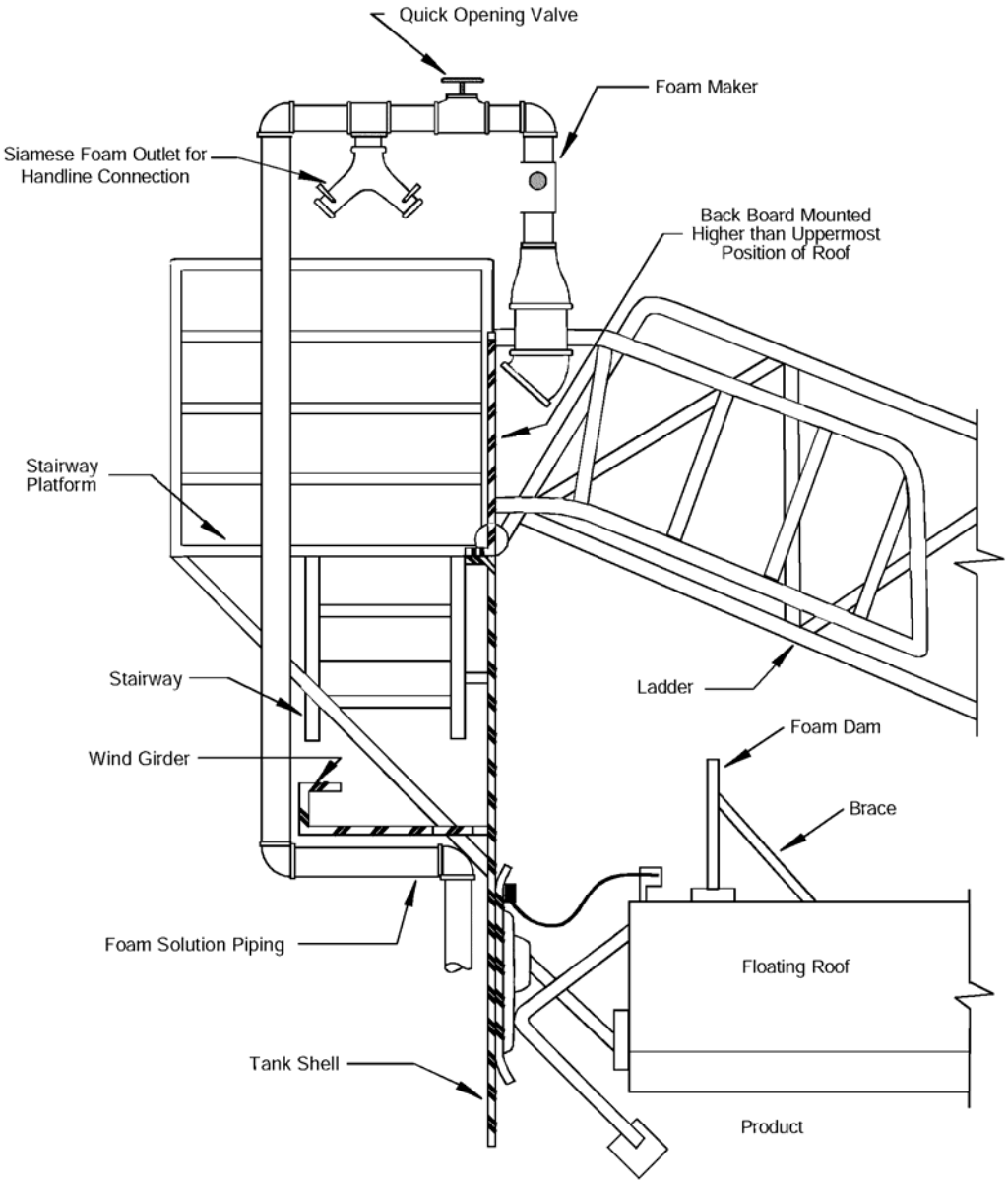
SEAL AREA PROTECTION USING A FOAM MAKER OR HANDLINE NOZZLE FROM LADDER AREA



D022rv195

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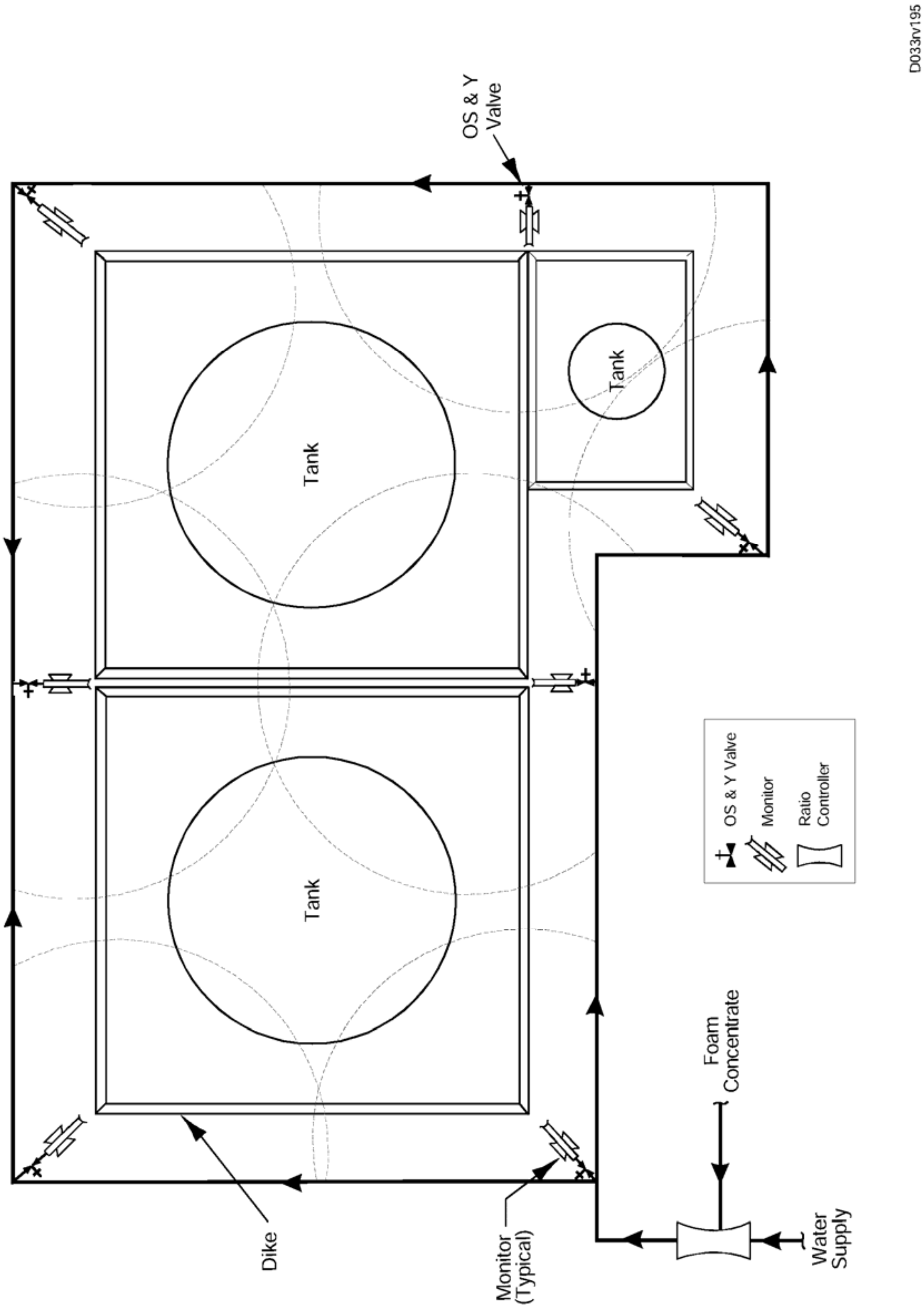
TANK AND DIKE PROTECTION WITH FOAM MONITOR SYSTEM



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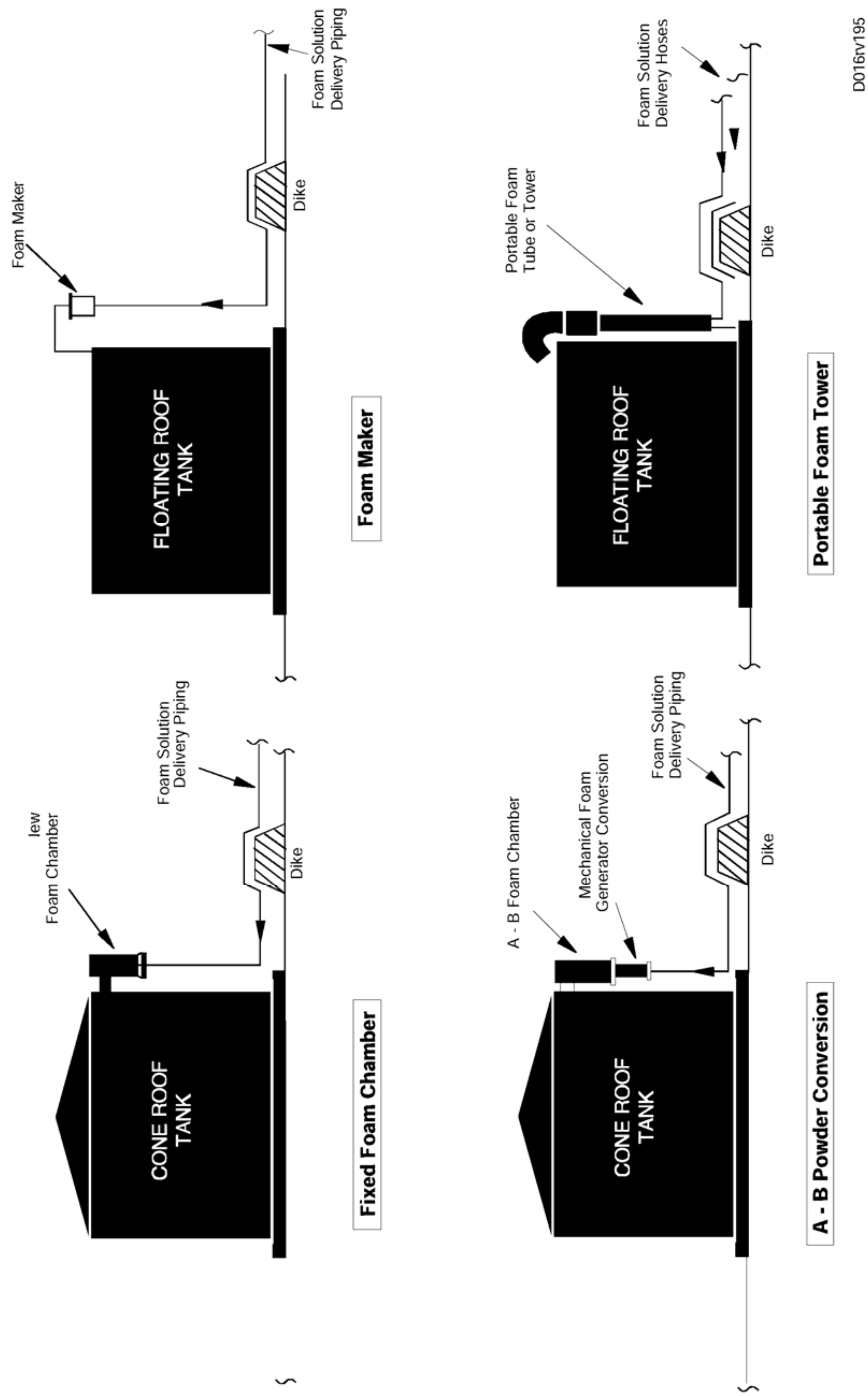
STORAGE TANK PROTECTION
Topside Applications



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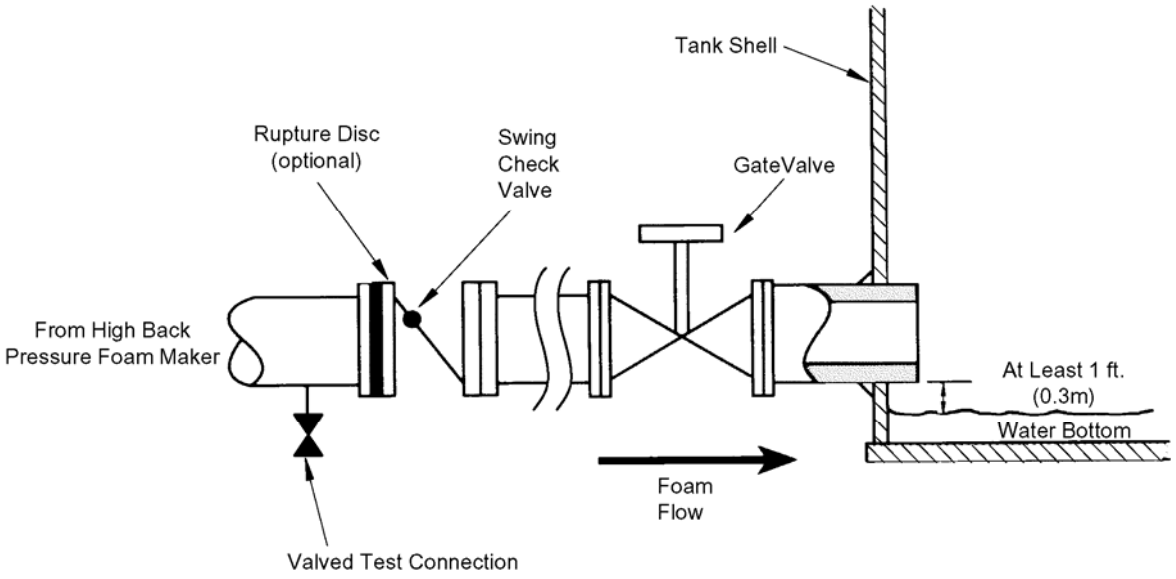
TYPICAL ARRANGEMENT FOR SUB-SURFACE SYSTEMS INTO A CONE ROOF STORAGE TANK



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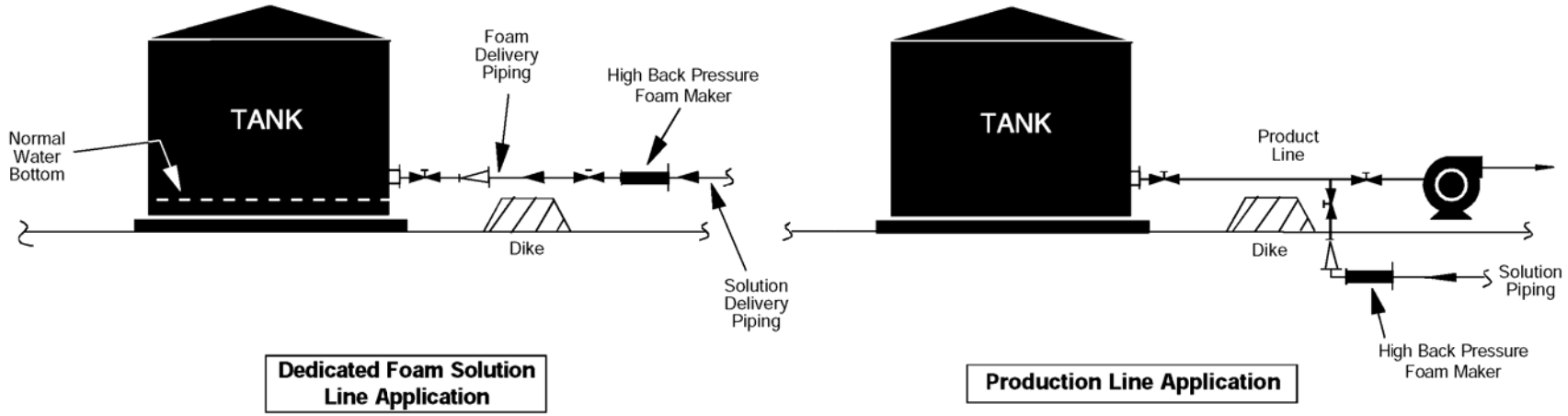
STORAGE TANK PROTECTION

Sub-surface Applications

(Hydrocarbon Fuels Only)



Dedicated Foam Solution Line Application

Production Line Application

Although dedicated lines may be used to apply foam using the subsurface method, additional economies may be realized by using existing product lines for foam injection.

In some installations a total tank farm may be covered by using a single subsurface injection station at the product line manifold.

The piping pressure losses and the inlet injection velocity must be verified by calculation. This is to be done with each product line which is a candidate for subsurface injection.

D017rv195

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STORAGE TANK PROTECTION SUMMARY

		Fixed-Roof (Cone) Tanks	Pontoon or Double-Deck Floating Roof Tanks
Foam Outlets Under Floating Roof Tank Seals or Metal Secondary Seal	Number Required	Not applicable	Mechanical Shoe Seal. 1 - For each 130 ft. (39.6 m) of tank circumference (no foam dam required) Tube Seal - Over 6 in. (15.2 cm) from top of seal to top of pontoon with foam outlets under metal weather shield or secondary seal. 1 - For each 60 ft. (18.3 m) of tank circumference (no foam dam required) Tube Seal - Less than 6 in. (15.2 cm) from top of seal to top of pontoon with foam outlets under metal weather shield or secondary seal. 1 - For each 60 ft. (18.3 m) of tank circumference (foam dam at lease 12 in. (30.5 cm) high required).
	Hydrocarbon Application Rates	Not Applicable.	0.30 gpm. (1.14 L/min.) per sq. ft. (sq. m) of annular ring area with foam dam or with foam application under metal weather seal or secondary seal. 0.50 gpm (1.9 L/min.) per sq. ft. (sq. m for all other applications).
	Discharge Times	Not Applicable.	20 min. - with foam dam or under metal weather shield or secondary seal.
	Polar Solvents	Not Applicable.	Not covered by NFPA 11.
Foam Handlines and Monitors For Thank Protection	Size of Tank	Monitors for tanks up to 60 ft. (18.3 m) in diameter. Hand hoselines for tanks less than 30 ft. (9.2 m) in diameter and less than 20 ft. (6.1 m) high.	Monitors not recommended. Handlines are suitable for extinguishment of rim fires in open-top floating roof tanks.
	Hydrocarbon Application Rates	0.16 gpm/ft^2. [(6.5 L/min.)/(m^2)]	0.16 gpm/ft^2. (6.5 L/min./m^2) For rim fires in open-top floating roof tanks.
	Discharge Times	Flash point below 100ºF (37.8ºC) 65 min. Flash point 100ºF - 140ºF 50 min. Crude Oil 65 min.	Use same times as for open-top floating roof tank rim fires.
Subsurface Application Outlets	Number Required	Same as table for foam chambers.	Not Recommended.
	Hydrocarbon Application Rates	Minimum 0.1 gpm/ft^2. [(4.1 L/min.)/m^2] of liquid surface. Maximum 0.2 gpm/ft^2. [(8.2 L/min.)/m^2] Foam velocity from outlet shall not exceed 10 ft. per sec. (3.05 m per sec.) for Class 1B liquids or 20 ft. per sec. (6.1 m per sec.) for all other liquids.	Not Recommended.
	Discharge Times	Flash point 100ºF (37.8ºC) 30 min. To 140ºF (194.4ºC) Flash point below 100ºF (37.8ºC) 55 min. Crude Petroleum 55 min.	Not Recommended.
	Polar Solvents	Not Recommended	Not Recommended

For S1 units: 1 gpm/ft^2. = 40.746 (L/min.)/m^2; 1 ft. = 0.305 m; 1 ft^2. = 0.0929 m^2; 1 in. = 0.0245 m; ºC = ºF - 32/1.8.

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STORAGE TANK PROTECTION SUMMARY

		Fixed-Roof (Cone) Tanks and Pan-Type Floating Roof Tanks	Pontoon or Double-Deck Floating Roof Tanks, (Open-Top or Covered) Annular Seal Area
Top Side Foam Application	Number Of Foam Outlets Required	Up to 80 ft. (2.44 m) dia. — 1 Foam Chamber 81 to 120 ft. (24.7 - 36.6 m) dia. — 2 Foam Chambers 121 to 140 ft. (36.9 - 42.7 m) dia. — 3 Foam Chambers 141 to 160 ft. (43 - 48.8m) dia. — 4 Foam Chambers 161 to 180 ft. (49 - 54.9 m) dia. — 5 Foam Chambers 181 to 200 ft. (55.2 - 61 m) dia. — 6 Foam Chambers Over 210 ft. (61.2 m) — 1 additional for each 5,000 sq. ft.	1 for each 40 ft. (12.2 m) of circumference with a 12-inch (30.5 cm) high foam dam. 1 for each 80 ft. (24.4 m) of circumference with a 24-inch (61 cm) high foam dam.
	Hydrocarbon Application Rates	0.10 gpm (0.38 L/min.) per sq. ft. (sq. m) of liquid surface.	0.30 gpm. (1.14 L/min.) per sq. ft. (sq. m) of annular ring area between tank wall and foam dam.
	Polar Solvent Rates	See Manufacturer's Approval Report.	Not covered by NFPA 11.
	Hydrocarbon Application Times	Type I / Type II Flash Pt. 100ºF - 140ºF (37.8ºC - 194.4ºC — 20 min. / 30 min. Flash Pt. Below 100ºF (37.8ºC) — 30 min. / 55 min. Crude Petroleum — 30 min. / 55 min.	20 min.
	Polar Solvents	Type I — 30 min. Type II — 55 min.	Not covered by NFPA 11.

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SURFACE APPLICATION

Determining Discharge Time and Application Rate (Cone Roof Tanks)

Discharge time and application rates are determined according to the type of fuel contained in the storage tank being protected. The following are minimum discharge rates recommended by Chemguard.

		Foam Chambers As Primary Protection			-OR-	Monitors/Hand Hose Lines As Primary Protection		
Fuel Protected	**Foam Concentrate**	**Application Rate gpm/ft^2**	**(Lpm/m^2)**	**Discharge Time**		**Application Rate gpm/ft^2**	**(Lpm/m^2)**	**Discharge Time**
Hydrocarbon								
Flash point	AR-AFFF	.10	(4.1)	30 min.		.16	(6.5)	50 min.
between	Fluoroprotein	.10	(4.1)	30 min.		.16	(6.5)	50 min.
100ºF and	AFFF	.10	(4.1)	30 min.		.16	(6.5)	50 min.
200ºF (38ºC and 93ºC)								
Hydrocarbon								
Flash point	AR-AFFF	.10	(4.1)	55 min.		.16	(6.5)	65 min.
below 100ºF	Fluoroprotein	.10	(4.1)	55 min.		.16	(6.5)	65 min.
(38ºC) or	AFFF	.10	(4.1)	55 min.		.16	(6.5)	65 min.
liquid heated above flash point								
Crude Petroleum	AR-AFFF	.10	(4.1)	55 min.		.16	(6.5)	65 min.
	Fluoroprotein	.10	(4.1)	55 min.		.16	(6.5)	65 min.
	AFFF	.10	(4.1)	55 min.		.16	(6.5)	65 min.
Alcohols								
Methanol								
	U.G.	.10	(4.1)	55 min.		.16	(6.5)	65 min.
	3/6	.10	(4.1)	55 min.		.16	(6.5)	65 min.
Ethanol								
	U.G.	.10	(4.1)	55 min.		.16	(6.5)	65 min.
	3/6	.10	(4.1)	55 min.		.16	(6.5)	65 min.
Isopropanol								
	U.G.	.15	(6.1)	55 min.		.16	(6.5)	65 min.
	3/6	.15	(6.1)	55 min.		.16	(6.5)	65 min.
Ketones								
Methyl Ethyl Ketone								
	U.G.	.10	(4.1)	55 min.		.16	(6.5)	65 min.
	3/6	.10	(4.1)	55 min.		.16	(6.5)	65 min.
Acetone								
	U.G.	.15	(6.1)	55 min.		.24	(9.8)	65 min.
	3/6	.15	(6.1)	55 min.		.24	(9.8)	65 min.
Aldehydes								
	U.G.	.17	(6.5)	55 min.		.16	(6.5)	65 min.
	3/6	.17	(6.5)	55 min.		.16	(6.5)	65 min.
Esters								
	U.G.	.10	(4.1)	55 min.		.16	(6.5)	65 min.
	3/6	.10	(4.1)	55 min.		.16	(6.5)	65 min.
Ethers								
	U.G.	.15	(6.1)	55 min.		.24	(9.8)	65 min.
	3/6	.15	(6.1)	55 min.		.24	(9.8)	65 min.

U.G. Ultraguard 3% AR-AFFF
3/6 3% - 6% AR-AFFF @ 6% Proportioning