Report of the Foam Committee

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The report of the Foam Committee is in 2 parts. Part I deals with revision of NFPA No. 11 and Part II deals with revision of NFPA No. 11B.

Part I has been submitted to letter ballot of the Foam Committee which consists of 24 voting members, of whom 22 have voted affirmatively, 2 (Mr. Easley and Mr. Fulton) have not returned their ballots.

Part II has been submitted to the Foam Committee which consists of 24 voting members of whom 17 have voted affirmatively, 1 (Mr. Lindsay) has voted negatively and 6 (Messrs. Easley, Fulton, Havener, McLaughlin, Perry, and Rivkind) have not returned their ballots.
Part I

Proposed Revisions to the
Standard for Foam Extinguishing Systems
NFPA No. 11 - 1974

1. Revise 1121 to read as follows:

   1121. AIR FOAM or MECHANICAL FOAM is made by mixing air into a water solution containing a foam concentrate by means of suitably designed equipment. One gallon of foam solution will produce about 8 gallons of air foam. This figure is representative of playpipe performance and delivery from fixed air foam makers of the low back pressure type. Foam production from high back pressure type foam makers is 4 gallons of air foam per gallon of solution or less, varying with the back pressure imposed.

2. Revise 113 to read as follows:

   113. AIR FOAM CONCENTRATE. Air foam concentrate is a concentrated liquid foaming agent as received from the manufacturer.

3. Revise 1133.(3) to read as follows:

   (3) Other Synthetic Concentrates are also based on hydrocarbon surface active agents and are listed as wetting agents and/or as foaming agents. In general, their use is limited to portable nozzle application to spill fires within the scope of their listings by nationally recognized laboratories. Guidance for use of the materials is given in NFPA No. 11B, Synthetic Foams and Combined Agents Systems.

4. Add a new 142.(8) to read as follows:

   (8) The manufacturer of the concentrate shall be consulted regarding storage life when the concentrate is to be used in a pre-mix solution.

5. Add new 148 to read as follows:

   148. Consideration shall be given to potential contamination of water supplies, treating systems, and effluent by foam or solution runoff.
6. **Renumber existing *164 as *165 and add new 164 as follows:**

164. **TEMPERATURE:** Optimum foam production is obtained using water at temperature between 40°F and 100°F. Higher or lower water temperatures may reduce foam efficiency.

7. **Add new second sentence to 1735 so as to read:**

1735. **PIPE SIZES.** Since effective protection depends on having an adequate volume of water (or solutions) at proper pressure, available at the foam-making devices, each system requires individual consideration as to the size of the piping. The water pressure of the inlet to air foam makers should preferably be not less than 50 psig. Operation is, however, possible with water pressure as low as 30 psig. Friction losses in pipe and fittings carrying water or foam solutions shall be determined by the Hazen and Williams formula using a value of 120 for “c”. Pipe sizes shall be so selected as to produce the proper delivery rate and pressure at the discharge outlet. (See Chapter 7 of NFPA No. 13 for hydraulic calculation procedures). For friction losses in piping carrying foam, see A-3561.

8. **Revise 241 and add a new 2411 as follows:**

241. **For Area Protection.**

2411. The duration of foam discharge shall be a minimum of 10 minutes. When a system has been designed to have a delivery rate higher than that specified under 230, a proportionate reduction in the discharge time may be made except that it shall not be less than seven minutes.

9. **Delete 243 and renumber 244 as 243.**

244. For tanks of 400 square feet and larger liquid surface area, apply the operating time rules for outdoor tanks.

9a. **Delete second sentence from 252 so as to read:**

252. There shall be a quantity of foam producing materials sufficient to supply the system in accordance with 230 and 240.
10. Add the word generally to the first sentence of 3311 so as to read:

*3311. OPEN TOP FLOATING ROOF TANKS: Fixed outlets are generally not required on open top floating roof tanks.

11. Revise 3312 to read as follows:

3312. COVERED FLOATING ROOF TANKS: Fixed outlets are generally not required on covered floating roof tanks. The possibility of fire is greatly reduced in comparison with other types because of the Faraday Cage type construction of this type of tank. In the event of fire, these tanks are difficult to extinguish using portable equipment. Fixed protection may be desired in certain locations because of value of products stored, remoteness of installations, or lack of fire-fighting personnel. Suggested methods for providing fixed foam systems for these tanks will be found in the Appendix.

Note: A "Faraday Cage" is a grounded metallic screen completely surrounding a space or piece of equipment in order to shield it from external electrostatic influence.

12. Add "diked area fires" to the third sentence of 601 to read:

*601. SCOPE: This chapter relates to systems in which the foam is applied through fixed or portable monitor or hose nozzles. They are usually recommended as auxiliary protection in conjunction with fixed piping systems or portable towers as specified in Chapters 3 and 4. They are suitable when used alone for extinguishment of spill fires, diked area fires, and fires in small fixed roof atmosphere storage tanks. Portable hose nozzles are also suitable for extinguishment of rim fires in floating roof tanks.

13. Revise Note 1 of 601 to read:

Note 1: Fires in tanks up to 180 feet in diameter have been extinguished when the entire liquid surface was involved by use of large capacity foam monitors. Depending on the fixed roof tank outage and fire intensity, the updraft due to chimney effect may prevent sufficient foam from reaching the burning liquid surface for formation of a blanket. Foam must 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, will reduce the
effectiveness of the foam stream. Due to their limitations, monitors should not be depended upon as a primary means of extinguishment for fixed roof tanks over 60 feet in diameter. Monitors operated at grade usually are not recommended for floating roof rim fire extinguishment because of the difficulty of directing foam into the annular space. Fixed foam monitors may be installed for protection of drum storage areas or diked areas.

14. Add the following Note 3 to 601:

NOTE 3: Large spill fires have been extinguished by foam monitors and foam hose streams. In order to obtain maximum flexibility due to the uncertainty of location and the extent of a possible spill in large tank farms, portable or trailer-mounted monitors are preferred to fixed foam systems. The procedure for fighting dikes area fires is to extinguish or secure one area and then move on to extinguish the next section, within the dike. This technique should be continued until the complete dike area has been extinguished. Generally, trailer or portable monitors, in addition to a few foam hose streams, have been adequate in fighting diked areas and other large spill fires.

15. Revise 602c and 602d to read as follows:

(c) FIXED MONITOR (Cannon): A device which delivers a foam monitor stream and is mounted on a stationary support at grade or elevated. The monitor may be fed solution by permanent piping or hose.

(d) PORTABLE MONITOR (Cannon): A device which delivers a foam monitor stream and is on a movable support or wheels so it can be transported to the fire scene.

15a. Delete 6110 (1), (2), and (3) and replace with the following:

6110. FOR LIQUID HYDROCARBONS:

(1) For tank protection the foam solution delivery rate shall be at least 0.16 gpm/sq. ft. of liquid surface area to be protected.


17. Delete A-115 and Figure A-115.


19. Revise A-121(a) to read as follows:
A-121(a) Air Foam Hose Nozzle with Built-In Inductor. Figure A-121(a) shows this type of proportioner where the jet in the foam maker is utilized to draft the concentrate.

Limitations: The bottom of the concentrate container should not be more than six feet below the level of the foam maker. The length and size of hose or pipe between the concentrate container and the foam maker should conform to the recommendations of the manufacturer.

20. Add new Figure A-121(a).

Fig. A-121(a). Air foam nozzle with built-in inductor.

21. Renumber Figure A-121(b)(1) to Figure A-121(b)(1)(a).

22. Add new Figure A-121(b)(1)(b).
Fig. A-121(b)(1)(b). In-Line Inductor.
23. Change “and even” to “or cause” in A-121(c)(1) so as to read:

LIMITATIONS:
1. The pressure on the water suction line at the pump must be essentially zero gage pressure or on the vacuum side. A small positive pressure of the pump suction can cause a reduction in the quantity of concentrate educted or cause the flow of water back through the eductor into the concentrate container.

24. Change heading of A-121(d) to “Balanced Pressure Proportioning.”

A-121(d). BALANCED PRESSURE PROPORTIONING: By means of an auxiliary pump, foam compound is injected into the water stream passing through an inductor. The resulting foam solution is then delivered to a foam maker or play pipe. The inductor may be inserted in the line at any point between the water source and foam maker or play pipe.

25. Replace existing Figure A-121(d) “Metered Proportioning” with the following: “Balanced Pressure Proportioning.”
Fig. A-121(d). Balanced pressure proportioning.

26. Replace Figure A-121(e) with the following:
Fig. A-121(e). Typical arrangement of pressure proportioner with single operating head.

27. Replace Figure A-121(f) with the following:

Fig. A-121(f). Coupled water motor pump proportioner.
28. Replace Figure A-122(a)(2) with the following:

![Handline foam nozzle](image1)

**Fig. A-122(a)(2).** Handline foam nozzle.

29. Add new Figure A-122(b) "High Back Pressure Foam Maker."

![High back pressure foam maker](image2)

**Fig. A-122(b).** High back pressure foam maker.
30. Delete A-122(c) including Figure A-122(c).


32. Renumber Figure A-132(a)(5) to Figure A-131(a) with the following caption:

Figure A-131(a). Dual Hopper Chemical Foam generator of the two powder type.

33. Renumber Figure A-132(a)(4) as Figure A-131(b) with the following caption:

Figure A-131(b). Single Hopper Chemical Foam generator of the single powder type.


35(a). Delete A-141(2).

36. Revise A-142 to read as follows:

A-142. LIMITATIONS: The possibility and extent of damage by the agent must be evaluated in the choice of any extinguishing system. In certain cases, such as tanks or containers of edible oils, cooking oils, or other food processing, or in other cases where contamination through the use of foam could increase the loss potential substantially, the authority having jurisdiction should be consulted as to the type of extinguishing agent preferred.


38. Delete A-170 and A-1735.

39. Change the word “shall” to “should” in the last paragraph of A-180 so as to read:
A-180. The concentration of foam liquid in solution should be determined. The rate of solution discharge may be computed from hydraulic calculations utilizing recorded inlet and/or end-of-system operating pressure. The foam liquid concentrate consumption rate may be calculated by timing a given displacement from the storage tank or by refractometric means. The calculated concentration and the foam solution pressure should be within the operating limit recommended by the authority having jurisdiction.

40. Renumber Figure A-170 to Figure A-300.

41. Change the word “liquid” to “concentrate” in revised Figure A-300 and delete second sentence from caption.

42. Renumber Figure A-302A as Figure A-302(b)(1).

43. Change figure references in A-302(b) as follows:
   Figure A-302A to Figure A-302(b)(1), Figure A-302B to Figure A-302(b)(2) and Figure A-302C to Figure A-302(b)(3).

44. Renumber Figure A-302B as Figure A-302(b)(2) and change figure reference in A-302(b) “Foam Trough.”

45. Change figure reference in 302(b) “Foam Chute” from Figure A-302C to Figure A-302(b)(3).

46. Change figure reference in A-302(c) “Type II Discharge Outlets” from A-302D and A-302E to A-302(c) and A-302(d).

47. Renumber Figure A-302C as Figure A-302(b)(3).

48. Renumber Figure A-302D as Figure A-302(c), delete small piping and show larger connection as indicated. Revise caption to read: “Air Foam Chamber with Type II Outlet.”
Figure A-302(c). Air Foam Chamber with Type II Outlet.

49. Delete A-302D.

50. Delete A-311.

51. Delete Figure A-302E.
52. Add new Figure A-302(d).

Fig. A-302(d). Semi-fixed subsurface foam installation.

53. Add new Figure A-302(f)(1)(a).

Fig. A-302(f)(1)(a). Standard foam truck-waterpump, proportioning system, airfoam concentrate tank and monitor nozzle.
54. **Add new Figure A-802(f)(1)(b).**

**TYPICAL AIR FOAM PIPING FOR INTERMEDIATE BACK PRESSURE FOAM SYSTEM**

![Diagram of typical air foam piping for intermediate back pressure foam system]

**Note 1**
One brace (1/8" plate, 12" long) is to be provided at each shell course. This will help keep the shell in place during the early stages of the fire and prevent buckling before cooling water is applied.

**Fig. A-802(f)(1)(b).** Typical air foam piping for intermediate back pressure foam system.
55. Renumber A-312 as A-3111 and change the word “shall” to “should” in the second and third sentences.

56. Add the following to A-324:

A-324. The supplementary hose stream requirements as given herein are not intended to protect against fires involving major fuel spills; rather, they are considered only as first-aid type protection for extinguishing or covering small spills involving areas in square feet equal to about six times the rated capacity (in gpm) of the nozzle.

57. Add the following to A-331:

A-331. Figure A-331 (a) and (b) are typical fixed foam discharge outlets or foam chambers.

58. Revise A-3311 to read as follows:

A-3311. OPEN TOP FLOATING ROOF TANKS. Within the scope of this standard, tanks without fixed roofs are open top tanks which have double deck pontoon type floating roofs and are constructed in accordance with the requirements set forth in NFPA No. 30, Flammable and Combustible Liquids Code. The design is furnished with a pantograph type seal or a tube seal with metal weather shield. See Figures A-3311(1) and A-3311(2). Plastic blankets, floating diaphragms or closures which are easily submerged are not included in this definition.

Two techniques are available for application of foam from fixed outlets. One involves discharge of foam above the pantograph seal or the metal weather shield. The other involves discharge of foam below the pantograph seal directly onto the flammable liquid surface or behind the metal weather shield directly on the tube seal envelope and the flammable liquid surface depending on tube seal damage.

59. Add new Figures A-3311(1) and A-3311(2).
Fig. A-3311(1). Pantograph type seal-open top floating roof tank.
Fig. A-3311(2). Tube seal-open top floating roof tank.
60. Revise A-3312 to read as follows and add new Figure A-3312:

A-3312. COVERED FLOATING ROOF TANKS. Within the scope of this standard, Covered Floating Roof Tanks are open-vented fixed roof tanks with a metal pan floating on the liquid surface and with venting provided as set forth in Appendix H of API Bulletin 650, "Welded Steel Tanks for Oil Storage" (see Figure A-3312). Venting should then be sufficient to maintain the vapor space below the lower flammable limit except during initial fill and for a short period thereafter, depending on the volatility of the product. When a Covered Floating Roof Tank is not designed according to API Bulletin 650, it shall be treated as a fixed roof tank.

Fig. 3312. Seal on floating metal pan of covered floating roof tank.
61. Delete first paragraph and table of A-342 so that it starts at:

A-342. For single line chemical foam generator systems, the following table, based on 100 lbs. per square inch indicated flow pressure at the generator inlet, will serve as a guide to the sizes and lengths of piping which may be used:

62. Delete entire last paragraph of A-342 beginning with "Foam production will be somewhat ..." on page 11-82.

63. Renumber Figure A-342(A) as A-331(a).

64. Delete Figure A-342(B) and add new Figure A-331(b) in its place.

Fig. 331(b). Foam chamber and foam maker.
65. Replace Figure A-501B with the following:

![Image](https://via.placeholder.com/150)

Fig. 501(B). Truck loading rack foam spray system.

66. Place the reference A-602 before the fourth paragraph on page 11-92. A-602 is to read as follows:

A-602. Foam nozzle and monitor streams may also be employed for the primary protection of stills, condensers, buildings and floating roof tanks, subject to the approval of the authority having jurisdiction. It is important that the discharge characteristics of the equipment selected to produce foam nozzle and monitor streams for outdoor storage tank protection be verified by actual test to make certain that the streams will be effective on the hazards involved.

Permanently installed foam hydrants, where used should be located in the proximity of the hazard protected and in safe and accessible locations. Location should be such that excessive lengths of hose are not required. Limitations as to length of hose which may be used depend upon the type of stream and its back pressure limitations.

Fig. A-601(1). Foam truck with monitor on articulated boom water pump, proportioning system, and airfoam concentrate.

Fig. A-601(2). Triple-Agent Foam Truck. Water pump, proportioning system, agent tanks and monitors for airfoam, dry chemical and AFFF.
Fig. A-602(c)(1). Fixed Foam-Water Monitors protecting oil piers.

Fig. A-602(c)(2). Fixed Foam-Water Monitors Protecting Oil Piers.
Fig. A-602(c)(3). Remote Operated Foam-Water Monitor.

Fig. A-602(c)(4). Adjustable Straight-Stream-to-Spray Foam-Water Monitor.
Fig. A-602(c)(5). Adjustable Straight Stream-to-Spray Foam-Water Monitor.

Fig. A-602(d)(1). Wheeled Portable Foam-Water Monitor.
Fig. A-602(d)(2). Portable Foam-Water Monitor.

Fig. A-602(d)(3). Trailer Mounted Portable Foam-Water Monitor.
Part II

Proposed Revisions to the Standard for

Synthetic Foam and Combined Agent Systems

NFPA No. 11B — 1973

1. Replace the third paragraph on page 11B-7 with:

The possibility and extent of damage by the agent must be evaluated in the choice of any extinguishing system. In certain cases, such as tanks or containers of edible oils, cooking oils, or other food processing, or in other cases where contamination through the use of AFFF could increase the loss potential substantially, the authority having jurisdiction should be consulted as to the type of extinguishing agent preferred.

Consideration should be given to potential contamination of water supplies and effluent treating systems by foam or solution run-off.

2. Revise subsection 2320, Minimum Discharge Time, to read:

2320. Minimum Discharge Time.

2321. For area protection the duration of AFFF discharge shall be a minimum of 10 minutes. If the system discharges at a rate above the minimum, the minimum discharge time may then be reduced proportionately, but shall not be less than seven minutes.

2322. For inside tanks of less than 400 square feet of liquid surface the duration of AFFF discharge shall be a minimum of five minutes.

2323. Operating Supply: There shall be a quantity of AFFF concentrate sufficient to supply the system at the discharge rate for a period of ten (10) minutes.

3. Add to the end of 3111: “for extinguishment of spill fires and fire in open dip tanks. Recommendations for protection of exterior storage tanks are given in Chapter 5.”

4. Delete second paragraph of 3112.
5. Revise Chapter 5 to read as follows:

CHAPTER 5.

SYSTEMS FOR EXTERIOR STORAGE TANK

NOTICE: An asterisk (*) preceding the number or letter designating a subdivision indicates explanatory material on that subdivision in Appendix A.

5100. General.

5110. Scope and Application: This chapter relates to application of AFFF to outdoor atmospheric storage tanks containing flammable or combustible liquids. These systems may consist of fixed pipe arrangements, semifixed installations, and portable equipment.

Note: Tanks containing Class III combustible liquids (at or above 140°F flash point) are not, as a rule, required to be protected by foam. Foam protection for combustible liquids may be desirable where abnormal situations exist, such as storage of high value stocks or liquids heated above their flash point.

5120. Limitations.

5121. Tests have shown that AFFF is susceptible to breakdown, loss of burnback resistance, and failure 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. The standards given in this chapter are based on extrapolation of test experience and appropriate listings, and reflect the limitations known to date.

5130. Definitions.

5131. Fixed Foam Discharge Outlet: A device permanently attached to a tank by means of which foam is introduced into the tank.

5132. Type II Discharge Outlet: An approved discharge outlet which does not deliver foam gently onto the liquid surface but is designed to lessen submergence of the foam and agitation of the surface.

5133. Subsurface Foam Injection: Discharge of foam into a storage tank from an outlet at the tank bottom or below the liquid surface.

5134. Fixed Installations: These are complete installations piped from a central foam house to the tanks, discharging through fixed delivery outlets on the tanks. Any required pumps are permanently installed.
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5135. Semi-Fixed Installations: The type in which tanks are equipped with fixed discharge outlets connected to piping which terminates a safe distance from the tanks. The piping may or may not include a foam maker. Necessary foam producing materials, foam making apparatus, hose, etc., are transported to the scene after the fire starts and are connected to the piping.

5136. Portable Foam Tower: A device which is brought to the scene of the fire, erected and placed in operation for delivering foam to the burning surface of a tank after the fire starts.

5137. Pressure Foam Maker (High Back Pressure or Forcing Type): A foam maker utilizing the Venturi principle for aspirating air into a stream of foam solution forming foam under pressure. Sufficient velocity energy is conserved in this device so that the resulting foam may be conducted through piping or hoses to the hazard being protected.

5200. Fixed and Semi-Fixed System Design.

5210. Surface Application Systems.

5211. General: Surface application systems utilize fixed foam discharge outlets for introduction of foam to the tank above the surface of the tank contents. The foam may be generated by means of a high pressure foam maker and delivered through pipe or hose line to the discharge outlets. AFFF concentrates and equipment for surface application systems shall be listed for this purpose.

5212. Actuation Time: Systems shall be designed to apply AFFF to the liquid surface in less than 10 minutes after ignition.

5213. Foam Application Rates: For tanks containing liquid hydrocarbons, the foam solution delivery rate shall be at least 0.1 gpm/sq. ft. of liquid surface area of the tank to be protected.

Note 1. AFFF systems may not be suitable for protection of products such as alcohols, esters, ketones, aldehydes, anhydrides, etc. Liquid hydrocarbons that contain such products, which are foam destructive, may require higher application rates. The manufacturer of the foam system should be consulted for recommendations.

Note 2. Flammable liquids having a boiling point of less than 100°F may require higher rates of application. Suitable rates of application should be determined by test.

Note 3. For higher viscosity liquids heated above 200°F, lower initial rates of application may be desirable to minimize frothing and expulsion of the stored liquid. Judgment must be used in applying foams to tanks containing hot oils, burning asphalts or burning liquids which are above the boiling point of water. Although the comparatively low water content of foams can beneficially cool such liquids at a slow rate, it can also cause violent frothing and "slop over" of the contents of the tanks.
5214. Supply of AFFF Concentrate: The minimum total supplies to be maintained shall be the sum of the quantities defined in 5214b, 5214c, 5214d, and 5214e.

(a) Minimum Discharge Times: The system shall be capable of operation at the delivery rate specified in 5213 for the tank to be protected, for the following minimum period of time:

- Lubricating oils; dry viscous residuum (more than 50 seconds Saybolt-Fural at 122°F); dry fuel oils and other liquid hydrocarbons with flash points above 200°F. 25 Min.
- Kerosene; light furnace oils, diesel fuels, etc., with flash points from 100°F to 200°F. 30 Min.
- Gasoline; naphtha, benzol and similar hydrocarbon liquids with flash points below 100°F. 55 Min.
- Crude Petroleum 55 Min.

(b) Requirements for Tanks: The quantity of AFFF Concentrate shall be determined by multiplying the total flow in gallons per minute for each tank by the appropriate time in 5214a. The largest resulting value shall determine the quantity required.

*(c) Supplementary Foam Hose Stream Requirements: Approved foam hose stream equipment shall be provided in addition to tank foam installations as supplementary protection for small spill fires. The minimum number of fixed or portable hose streams required shall be as specified in the following table, and shall be conveniently located to provide protection of the area. For the purpose of this requirement, the equipment for producing each foam hose stream shall have a solution rate of at least 50 gpm. Hose stream delivery quantities shall be in addition to quantities required for tank areas to permit operation of the hose stream equipment simultaneously with tank foam installations for the period set forth in the following table:
<table>
<thead>
<tr>
<th>Diameter of Largest Tank</th>
<th>Minimum Number of Hose Streams Required</th>
<th>Minimum Operating Time*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 35 ft</td>
<td>1</td>
<td>10 min.</td>
</tr>
<tr>
<td>Over 35 to 65 ft.</td>
<td>1</td>
<td>20 min.</td>
</tr>
<tr>
<td>Over 65 to 95 ft.</td>
<td>2</td>
<td>20 min.</td>
</tr>
<tr>
<td>Over 95 to 120 ft.</td>
<td>2</td>
<td>30 min.</td>
</tr>
<tr>
<td>Over 120 ft.</td>
<td>3</td>
<td>30 min.</td>
</tr>
</tbody>
</table>

*Based on simultaneous operation of the minimum number of 50 gpm hose streams required. Adjustments may be made where streams of greater capacity are provided.

(d) Requirements to Fill Pipe Line: A quantity of AFFF concentrate sufficient to produce AFFF solutions to fill the feed lines actually installed between the source and the most remote tank shall also be provided. Where a water supply source will continue after the AFFF concentrate is depleted and displace the solution or foam from the lines to the tank, no added quantity is required by this paragraph.

(e) Reserve Supply of AFFF Concentrate: There shall be a readily available reserve supply of foam producing materials sufficient to meet design requirements in order to put the system back into service after operation. This supply may be in separate tanks or compartments, in drums or cans on the premises, or available from an approved outside source within 24 hours.

5215. Fixed Discharge Outlets: For the protection of a flammable liquid contained in a storage tank, discharge outlets shall be attached to the tank. Where two or more discharge outlets are required, the outlets shall be equally spaced around the tank periphery and each outlet shall be sized to deliver AFFF at approximately the same rate. Fixed discharge systems shall be securely attached at the top of the shell and so constructed as to preclude the possibility of the tanks overflowing into the AFFF lines. They shall be securely attached so that displacement of the roof is not likely to subject them to serious damage.

(a) Tanks shall be provided with approved discharge outlets as set forth below:
Minimum Discharge Outlets

<table>
<thead>
<tr>
<th>Tank Diameter-Feet</th>
<th>Cone Roof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 80</td>
<td>1</td>
</tr>
<tr>
<td>Over 80 to 120</td>
<td>2</td>
</tr>
<tr>
<td>Over 120 to 140</td>
<td>3</td>
</tr>
<tr>
<td>Over 140 to 160</td>
<td>4</td>
</tr>
<tr>
<td>Over 160 to 180</td>
<td>5</td>
</tr>
<tr>
<td>Over 180 to 200</td>
<td>6</td>
</tr>
</tbody>
</table>

Note: It is suggested that for tanks above 200 feet in diameter, at least one additional discharge outlet be added for each additional 5000 sq. ft. of liquid surfaces. Since there has been no experience with AFFF application to fires in oil tanks over 75 feet in diameter, requirements for foam protection on tanks above this size are based on extrapolation of data from successful extinguishments in smaller tanks.

(b) Fixed outlets shall be provided with an effective and durable seal, frangible under low pressure, to prevent entrance of vapors into foam outlets and pipe lines. Fixed outlets shall be provided with suitable inspection means to permit proper maintenance and for inspection and replacement of vapor seals.

5216. Portable Towers: It is desired that at least one portable tower be provided as supplementary protection in the event that a fixed discharge outlet is damaged by an explosion within the tank.

*5217. Open Top Floating Roof Tanks: Fixed outlets are not required on open top floating roof tanks. These tanks have an excellent fire record. Their design has been for the purpose of fire prevention as well as for conservation of product. It is usually possible to utilize trained personnel to extinguish fires in the annular ring using portable equipment. There are locations, however, where fixed protection may be desired because of value of products stored, remoteness of installation, or lack of fire fighting personnel. Suggested methods for providing fixed foam systems for open top floating roof tanks will be found in the Appendix.

*5218. Covered Floating Roof Tanks: Fixed outlets are not generally required on covered floating roof tanks. The possibility of fire is greatly reduced in comparison with other types because of the Faraday cage type construction of covered floating roof tanks.

Note: A "Faraday Cage" is a grounded metallic screen completely surrounding a space or piece of equipment in order to shield it from external electrostatic influence.
5220. Subsurface Injection Systems for Tanks Containing Liquid Hydrocarbons.

*5221. General.

(a) Subsurface injection systems may not be suitable for protection of products such as alcohols, esters, ketones, aldehydes, anhydrides, etc. Liquid hydrocarbons that contain such products, which are foam destructive, may require higher application rates. The manufacturer of the foam system should be consulted for recommendations.

(b) AFFF concentrates and equipment for subsurface injection shall be listed for this purpose.

5222. Actuation Time: Systems shall be designed to apply AFFF to the liquid surface in less than 10 minutes after ignition.

5223. Foam Properties: For subsurface injection purposes AFFF expansion shall be in the range of 2.0 to 3.0 (at atmospheric pressure) with a minimum of 25 percent drainage time of eight minutes when measured as in A6310.

5224. Foam Application Rates: For tanks containing liquid hydrocarbons the foam solution delivery rate shall be at least 0.1 gpm/sq. ft. of liquid surface area of the tank to be protected. The maximum rate shall be 0.20 gpm/sq. ft.

Note 1: Flammable liquids having a boiling point of less than 100°F may require higher rates of application. Suitable rates of application should be determined by test.

Note 2: For high viscosity liquids heated above 200°F, lower initial rates of application may be desirable to minimize frothing and expulsion of the stored liquid. Judgment must be used in applying foams to tanks containing hot oils, burning asphalts or burning liquids which are above the boiling point of water. Although the comparatively low water content of foams can beneficially cool such liquids at a slow rate, it can also cause violent frothing and "slop over" of the contents of the tanks.

5225. Supply of AFFF Concentrate: The minimum total supplies to be maintained shall be the sum of the quantities defined in 5225b, 5214c, 5214d, and 5214e.

(a) Minimum Discharge Times: The system shall be capable of operation at the delivery rate specified in 5224 for the tank to be protected, for the following minimum period of time:
Lubricating oils; dry viscous residuum (more than 50 seconds Saybolt-Fural at 122°F); dry fuel oils and other liquid hydrocarbons with flash points above 200°F.  25 Min.

Kerosene; light furnace oils, diesel fuels, etc., with flash points from 100°F to 200°F.  30 Min.

Gasoline; naphtha, benzol and similar hydrocarbon liquids with flash points below 100°F.  55 Min.

Crude Petroleum  55 Min.

(b) Requirements for Tanks: The quantity of AFFF concentrate shall be determined by multiplying the total flow in gallons per minute for each tank by the appropriate time in 5-2.2.5a. The largest resulting value shall determine the quantity required.

5226. AFFF Discharge Outlets: The discharge outlet into the tank may be specially designed and installed for this purpose, or it may be a product line. Outlets shall be sized so that foam generator discharge pressure and foam velocity limitations are not exceeded. The foam velocity at the point of discharge into the tank contents shall not exceed 10 feet per second unless actual tests prove higher velocities are satisfactory. Where two or more outlets are required, they shall be equally spaced for even foam distribution and each outlet shall be sized to deliver foam at approximately the same rate. Outlets may be shell connections or may be fed through a pipe manifold within the tank from a single shell connection. Shell connections may be made in manway covers rather than installing additional tank nozzles.

5227. AFFF Discharge Outlet Elevation: Foam discharge outlets shall be located above an established water bottom. If it is established that there is a water bottom in the tank above the foam discharge outlets, it should be drained to below the point of foam injection prior to putting the foam system into operation. If this is not accomplished, efficiency will be reduced as a result of dilution of the foam, prolonging or preventing extinguishment.

5228. Numbers of AFFF Discharge Outlets: Tanks shall be provided with discharge outlets as set forth below:
Minimum Discharge Outlets

<table>
<thead>
<tr>
<th>Tank Diameter-Feet</th>
<th>Cone Roof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 80</td>
<td>1</td>
</tr>
<tr>
<td>Over 80 to 120</td>
<td>2</td>
</tr>
<tr>
<td>Over 120 to 140</td>
<td>3</td>
</tr>
<tr>
<td>Over 140 to 160</td>
<td>4</td>
</tr>
<tr>
<td>Over 160 to 180</td>
<td>5</td>
</tr>
<tr>
<td>Over 180 to 200</td>
<td>6</td>
</tr>
<tr>
<td>Over 200</td>
<td></td>
</tr>
</tbody>
</table>

NOTE 1: Class 1A liquids require special consideration.

NOTE 2: The above table is based on extrapolation of fire test data on 8, 15, 20 and 28 ft. diameter tanks containing heptane, gasoline, heptane and gasoline, respectively.

NOTE 3: AFFF subsurface injection systems are not recommended for high viscosity liquids of viscosity greater than about that of No. 6 fuel oil.

5230. AFFF System Piping.

5231. General Requirements:

(a) All piping inside of dikes, and within 50 feet of tanks not diked, should be buried under at least one foot of earth but may be permitted above ground if properly supported and protected against mechanical injury.

(b) Piping which is normally filled with liquids such as the suction pipes, shall be protected from freezing when necessary.

(c) In systems with semi-fixed equipment, the foam or solution laterals shall terminate in connections which are a safe distance from the tanks; outside of dikes and at least 50 feet from tanks of 50 foot diameter or less, and one tank diameter from the shell of larger tanks. The inlets to the piping shall be fitted with corrosion-resistant metal connections provided with plugs or caps.

(d) PIPE LINES CARRYING AFFF: Pipe lines carrying foam shall be of such sizes and lengths as to deliver the required quantity of foam to the surface to be protected. The size and length of discharge line used beyond foam making equipment should be in accordance with the conditions under which the device has been tested and listed.

(e) VALVES IN SYSTEMS: All valves, except hydrant valves shall be of the O.S. and Y or post indicator type. The laterals to each foam
inlet shall be separately valved in fixed installations. Control valves to divert the foam or solutions to the proper tank may be in the central foam house or may be at points where laterals to the protected tanks branch from main feed lines. In all such systems the control valves shall be clearly marked to indicate the normally open or normally closed position. Control valves shall be located outside dikes and not less than the following distances from the shell of the tank which they serve: 50 feet for tanks less than 50 feet in diameter; one diameter for tanks 50 feet in diameter or larger, except that control valves may be permitted at less than the above distances where adequately protected, subject to the approval of the authority having jurisdiction. Where two or more AFFF proportioners are installed in parallel discharging into the same outlet header, valves shall be provided between the outlet of each device and the header. The water line to each proportioner inlet should be separately valved.

(f) **AFFF System Hydrants:** Centralized fixed piping systems should be provided with hydrant outlets for foam hose streams for supplementary use on ground fires, supply portable towers, etc. In lieu of foam (or solution) hydrants, water hydrants, and portable foam-making equipment acceptable to the authority having jurisdiction may be provided. The minimum number of hydrants, each with at least one outlet, shall be located 50 to 250 feet from the shells of tanks protected as set forth below:

<table>
<thead>
<tr>
<th>Tank Diameter Feet</th>
<th>Minimum Number of Hydrants Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 65</td>
<td>1</td>
</tr>
<tr>
<td>65 and Over</td>
<td>2</td>
</tr>
</tbody>
</table>

5232. **Surface Application Considerations:** (a) Piping from the dike, or within 50 feet of tanks not diked, to the tank foam discharge outlet shall be designed to absorb the upward force and shock due to a tank roof rupture. Steel pipe and welded construction is preferred. One of the following designs may be used:

i. When piping is buried, a swing joint or other suitable means shall be provided at the base of each tank riser. The swing joint shall consist of a system of approved standard weight steel, ductile, or malleable iron fittings.

ii. When piping is supported aboveground, it shall have upward and lateral support as needed, but shall not be held down a
distance of 50 feet from the tank shell to provide flexibility in an upward direction so that a swing joint is not needed. Threaded connections shall be back welded for strength.

iii. When tank risers are four inch pipe size or greater, they can be welded to the tank by means of steel brace plates positioned perpendicular to the tank and centered on the riser pipe. One brace shall be provided at each shell course. This design may be used in lieu of swing joints or above ground flexibility as described above.

iv. One flanged or union joint shall be provided in each riser within five feet of the ground to permit hydrostatic testing of the piping system up to this joint. With all welded construction, this may be the only joint that can be opened.

5233. Subsurface Injection Considerations:

(a) PIPELINES CARRYING AFFF: The sizes and lengths of discharge pipe or lines used beyond the foam maker shall be such that the back pressure is within the range of pressures under which the device has been tested and listed by nationally recognized testing laboratories.

(b) VALVES IN SYSTEMS: In addition to the requirements specified in 5231e, each foam delivery line shall be provided with a valve and check valve unless the latter is an integral part of the high back pressure foam maker or pressure foam generator to be connected at time of use. When product lines are used for foam, product line valving shall be arranged to insure foam enters only the tank to be protected.

5300. Portable System Design.


5311. General: This subsection relates to systems in which the AFFF is applied through portable monitor or hose nozzles. They are usually recommended as auxiliary protection in conjunction with fixed piping systems as specified in 5200. They are suitable when used alone for extinguishment of spill fires, diked area fires, and fires in small fixed roof storage tanks. Portable hose nozzles are also suitable for extinguishment of rim fires in floating roof tanks.

NOTE 1: Due to their limitations, monitors should not be depended upon as a primary means of extinguishment for fixed roof tanks over 60 feet in diameter. Monitors operated at grade usually are not recommended for floating roof rim fire extinguishment because of the difficulty of directing foam into the annular space.
NOTE 2: Foam hose streams are suitable as a primary means of extinguisement of fires in tanks not over 30 feet in diameter nor over 20 feet high. Foam hose streams can be used for floating roof rim fire extinguisement when used from the tank wind girder or roof.

5312. AFFF Application Rates: The delivery rate for primary protection for tanks containing liquid hydrocarbons, based on the assumption that all the foam reaches the area being protected, shall be 0.16 gpm/sq. ft. of liquid surface area to be protected.

NOTE 1: When using portable monitors or hose nozzles consideration and allowance shall be made for internal convective currents, misapplication, and wind. These allowances could be up to 100 percent.

NOTE 2: Flammable liquids having a boiling point of less than 100°F, may require higher rates of application. Suitable rates of application should be determined by test.

NOTE 3: Judgment must be used in applying foam to tanks containing hot oils, burning asphalts or burning liquids which are above the boiling point of water. Although foams can beneficially cool such fuels at a slow rate, they can also cause violent frothing and "slop-over" of the contents of the tank.

5313. Supply of AFFF Material: The minimum total supplies to be maintained shall be the sum of the quantities defined in 5313b, 5214c, 5214d and 5214e.

(a) Minimum Discharge Times: The equipment shall be capable of operation to provide primary protection at the delivery rates specified in 5312 for the following minimum periods of time:

For Tanks Containing Liquid Hydrocarbons

<table>
<thead>
<tr>
<th>Fixed System</th>
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</thead>
<tbody>
<tr>
<td>For Tanks Containing Liquid Hydrocarbons</td>
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</tbody>
</table>

Lubricating oils, dry viscous residuum (more than 50 seconds Saybolt-Furol at 122°F.), dry fuel oils, etc., with flash point above 200°F 35 Min.
Kerosene light furnace oils, diesel fuels, etc., with flash points from 100°F to 200°F 50 Min.
Gasoline, naptha, benzol and similar liquids with flash points below 100°F. 65 Min.
Crude Petroleum 65 Min.

(b) Requirements for Tanks: The quantity of foam-producing material shall be determined by multiplying the total flow in gallons per minute for each tank by the appropriate time in 5313a. The largest resulting value shall determine the quantity required.

5314. Hose Requirements: Unlined Fabric Hose: Unlined fabric hose shall not be used with foam equipment.
6. Revise Page 11B-19 to read:

Part II
Hydrocarbon Surfactant Type Foam Concentrates

CHAPTER 1. GENERAL INFORMATION

1100. General Information. These are synthetic foaming agents generally based on hydrocarbon surface active agent. They produce foams of widely different character (expansion and drainage times) dependent on the type of foam-producing devices employed. In general, such foams do not provide the stability and burn-back resistance of protein-type foams nor the rapid control and extinguishment of AFFF, but can be useful for petroleum-product spill fire fighting in accordance with their listings or approvals.

There are hydrocarbon base foaming agents which have been listed as foaming agents, wetting agents or as a combination foaming/wetting agent. The appropriate listings shall be consulted to determine proper application rates and methods.

7. Revise the Appendix to include the following:

A5214C. Supplementary foam hose streams may be supplied directly from the main system protecting the tanks (e.g. in the case of centralized fixed pipe system) or may be provided by additional equipment. The supplementary hose stream requirements as given herein are not intended to protect against fires involving major fuel spills; rather, they are considered only as first-aid type protection for extinguishing or covering small spills involving areas in square feet equal to about 10 times the rated capacity (in gpm) of the nozzle.

A5217. Open Top Floating Roof Tanks: Within the scope of this standard, tanks without fixed roofs are open top tanks which have double deck or pontoon-type floating roofs and are constructed in accordance with the requirements set forth in NFPA No. 30, Flammable and Combustible Liquids Code. The design is furnished with a pantograph type seal or a tube seal with metal weather shield. (See Figures A5217(1) and A5217(2).) Plastic blankets, floating diaphragms or closures which are easily submerged are not included in this definition.

Two techniques are available for application of foam from fixed outlets. One involves discharge of foam above the pantograph seal or the metal weather shield. The other involves discharge of foam below the pantograph seal directly onto the flammable liquid surface or behind the metal weather shield directly on the tube seal.
envelope and the flammable liquid surface depending on the tube seal damage.

Fixed foam fire-fighting systems may be either manually or automatically operated or capable of both type operations. The design can utilize a fixed installation or, if manual, a semi-fixed installation.

(1) When it is desirable to provide fixed foam discharge devices above a pantograph-type continuous fabric seal or above the metal weather shield of a tube seal, the following may be used as a design guide:

(a) A circular dam made of at least No. 10 U. S. Standard Gage thickness (0.134 inches) steel plate should be welded or otherwise securely fastened to the floating roof. The purpose of the dam is to retain the foam at the seal area and to provide for sufficient depth (12 inches minimum) to cause the foam to flow laterally to a point where the seal may have been ruptured. The dam shall be slotted at the bottom to provide for drainage of rain water. Total drain slot areas should be 0.02 square inch per square foot of diked area, and the slots should be approximately 3/8 inch high. The foam dam should be at least 1 foot and not more than 2 feet from the edge of the roof.

(b) Precautions should be taken to prevent mechanical interference of foam devices and piping with the floating roof, the seal or weather shield and rolling ladder.

(c) The number of points of foam application are to be determined by the circumference of the tank. The maximum spacing between applicators should be 40 feet of tank circumference using a 12-inch-high dam and 80 feet of tank circumference using a 24-inch-high dam. The foam should be a low expansion, fluid-type of foam usually associated with drainage times near the “lower acceptable limit.”

(d) Rate of application and supply of foam liquid should be calculated using the area of annular ring between the circular dam and the tank shell. The minimum solution rate should be 0.16 gpm per square foot. The supply of foam liquid should be adequate to operate the system for 20 minutes.

(2) When it is desired to provide fixed foam devices below the fabric seal or metal weather shield, the following may be used as a design guide:

(a) A circular dam is required with the tube seal design only when the top of the tube seal is less than 6 inches below the top of the deck. The maximum spacing between applicators should be no more than 60 feet measured around the circumference of the tank.
(b) A circular dam is not required with the pantograph type seal. The maximum spacing between applicators should be no more than 130 feet measured around the circumference.

(c) The foam should be a low expansion type usually associated with drainage times near the lower acceptable limit.

(d) Precautions should be taken to prevent mechanical interference of foam devices or piping with the floating roof, seal linkages, or rolling ladder.

(e) The rate of application and the supply of foam liquid should be calculated using the area of the annular ring between the tank shell and the floating roof edge. The minimal rate should be 0.5 gpm per square foot of area. The supply should be adequate to operate the system for 10 minutes.

(3) Separately valved laterals for each foam discharge device are not required for systems protecting floating roof tanks with open tops.

A5218. Covered Floating Roof Tanks. Within the scope of this standard, covered floating roof tanks are open-vented fixed roof tanks with a metal pan floating on the liquid surface and with venting provided as set forth in Appendix H of API Bulletin 650, “Welded Steel Tanks for Oil Storage” (see note below). Venting should then be sufficient to maintain the vapor space below the lower flammable limit except during initial fill and for a short period thereafter, depending on the volatility of the product. When a Covered Floating Roof Tank is not designed according to API Bulletin 650, it shall be treated as a fixed roof tank.

Note: Vents in Covered Floating Roof Tanks. Suitable vents shall be provided to prevent overpressuring of the roof deck or seal membrane. These vents shall be adequate to evacuate air and gases from underneath the roof when the roof is on its supports during the filling operations. They shall also be adequate to relieve any vacuum generated underneath the roof after it still is on its supports during the withdrawal operations. The purchaser shall specify filling and emptying rates so that the fabricator may size the vents properly.

Circulation vents or openings shall be located in the tank shell above the seal of the floating roof when the tank is full. The maximum spacing shall be 32 ft., but in no case shall there be less than four (4) equally spaced vents. The total open area of these vents shall be equal to or greater than 0.2 sq. ft. per ft. of tank diameter.

An open vent shall be provided at the center or at the highest elevation of the fixed roof. It shall have a weather cover and a minimum open area of 50 square inches.

(1) When foam protection is desired for covered floating roof tanks, protection should be provided to cover the full liquid surface
in the event the floating roof sinks or is destroyed. In special cases where the floating pan may be pinned at the top of the tank, and foam protection is desired below the pan, discharge outlets should be located so that the tank is protected when the pan is in the pinned position. The foam system should be designed in accordance with Chapter 5 for other than floating roof tanks, except that separately valved laterals for each foam discharge device are not required. Subsurface or semi-subsurface methods are not recommended because of the possibility of improper distribution of foam.

(2) There has been no known fire experience with double deck or pontoon type floating roof tanks with fixed roof and venting in accordance with API 650. In view of the stability and excellent buoyancy of this type roof, when protection is desired, a fixed foam system for extinguishment of seal fires in the annular ring may be provided, as described in Paragraph A5217.

(3) When foam protection is desired for fixed roof tanks with internal floating covers made of materials other than steel, such as aluminum or plastic, protection should be designed to cover the full liquid surface in accordance with Chapter 5 for other than floating roof tanks.

A-5221. General: 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 conduct of operations a safe distance from the tank. Thus, opportunity for establishing and maintaining an adequate foam application rate is enhanced. The following guides regarding fire attack are suggested:

After necessary suction connections are made to the water supply and foam maker connections made to foam lines, foam pumping operations should be initiated simultaneously with opening of block valves permitting 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 may be a momentary increase in intensity caused by 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 to disrupt the established foam blanket.

After the fire has been substantially knocked down by the foam, some fire may remain over the point of injection. With liquids with flash points higher than average product temperature, this turbulent area fire is self-extinguishing as cool product is rolled to the surface and nearby hot shell surfaces are cooled. With low flash point Class IB liquids the fire over the turbulent area will continue until it is adequately covered by foam. Depending on local circumstances, it may be possible to extinguish any residual flickers over the turbulent area by use of portable equipment rather than continue the relatively high rate of application to the whole tank.

If the tank is completely filled with a burning liquid which forms a heat wave, a slop-over may 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 for liquids which do not form a heat wave, pump rate should be continuous. 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.