



# FOAM EXTINGUISHING SYSTEMS 1963

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# National Fire Protection Association

## International

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This is one of a large number of publications on fire safety issued by the Association. All NFPA standards and recommended practices, including this text, are prepared by the technical committees of the NFPA and adopted at an Annual Meeting of the Association. They are intended to prescribe reasonable measures for minimizing losses of life and property by fire.

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**SHALL** is intended to indicate requirements.

**SHOULD** is intended to indicate recommendations, or that which is advised but not required.

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## **Foam Extinguishing Systems**

**1963 Edition of No. 11**

The 1963 edition of the Standard for Foam Extinguishing Systems incorporates changes adopted at the 1963 Annual Meeting on recommendation of the Committee on Foam. The majority of changes or deletions made in this edition are for clarification of intent; however, new information is included in 1540, 1840, 3240 and new appendix material on protection of floating roof tanks.

### **Origin and Development of No. 11**

NFPA committee activity in this field dates from 1921 when the Committee on Manufacturing Risks and Special Hazards prepared standards on foam as a section of the general Standard on Protection of Fire Hazards Incident to the Use of Volatiles in Manufacturing Processes. Subsequently the standards were successively under the jurisdiction of the Committee on Manufacturing Hazards and the Committee on Special Extinguishing Systems, prior to the present committee organization. The present text supersedes the edition of 1960 and prior editions adopted in 1922, 1926, 1931, 1936, 1942, 1950, 1954, 1959 and 1960.

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**Standard for  
Foam Extinguishing Systems**

NFPA No. 11 — 1963

**FOREWORD.**

Foam is an aggregate of tiny gas-filled or air-filled bubbles, lighter than the lightest oils, which is used to form a fluid blanket floating on the surfaces of flammable liquids to smother the fire by excluding the air and also by stopping further formation and reignition of combustible gases. Because foam contains water dispersed in very thin films, it also has cooling properties.

Foam has the property of adhering to surfaces, combining a blanketing effect and a cooling effect for fire extinction and protection against adjacent fires. Foam has been used successfully to extinguish fires in flammable liquids, not only through the use of first-aid hand fire apparatus but also through other manual, automatic and semi-automatic means whereby foam may be applied to specific hazards or hazardous occupancies in industrial plants, in flammable liquid processing and refining operations, and to flammable liquid storage tanks.

While other extinguishing agents are also recognized as approved for use on flammable liquid fires, it should be noted that for flammable liquid fires in large storage tanks, only foam has to date been found practicable. Records show successful extinguishment of fires in oil tanks up to 140 ft. diameter.

Foam does not dissipate readily, and when applied at the proper rate, has the ability to extinguish fire progressively. As the application continues, foam flows easily across the burning surface in the form of a tight blanket, preventing reignition on the surfaces already extinguished.

Foam may be used in cases where water supplies are limited, since the total quantity of extinguishing material has a volume many times that of the water used.

In addition to the application of foam through fixed piping systems, foam may also be applied to advantage in many cases in the form of foam hose streams or through portable applicators or foam towers. This standard also covers these methods of foam application.

It should be noted that foam may be displaced by water as ordinarily applied from sprinklers or hose streams; and if floating upon a tank of oil, it may also be displaced by debris falling into the tank and causing overflow, the overflow carrying off the foam. The blanket, however, has the ability to reseal itself if it should be broken by falling debris. It is also quite tenacious, remains where applied, and is not readily dissipated by heat. Tests have shown that extinguishment of dip tank fires, by foam applied at standard rates, is not adversely affected by the simultaneous application of water from a standard sprinkler system.

In the absence of more suitable extinguishing media, foam may be used effectively on ordinary combustible materials (wood, paper, etc.).

Asterisks (\*) indicate additional information in Appendix in correspondingly numbered paragraphs.

## CHAPTER 1. GENERAL REQUIREMENTS AND INFORMATION.

### 110. Introduction.

111. PURPOSE: This standard covers the minimum requirements for the installation and use of foam systems and portable apparatus for fire protection and extinguishment and is prepared to cover the design, installation, operation and maintenance of such equipment and for the guidance of inspection departments and others charged with the inspection, supervision or local approval of installations of this type.

112. SCOPE: This standard covers the installation of foam systems ranging from automatic or manual systems on small dip tanks, or the simplest form of protection on a small isolated storage tank in an industrial property to elaborate systems for the protection of refineries, oil storage farms, fuel storage and handling installations at airports, or chemical manufacturers. For shipboard installations, consult General Rules and Regulations for Vessel Inspection, U. S. Coast Guard.

113. DEFINITION, FOAM—FOAM QUALITY: Fire fighting foam shall be an aggregation of small bubbles of lower specific gravity than oil or water, and shall show tenacious qualities for covering and clinging to vertical or horizontal surfaces. It shall have high water retention ability and be relatively stable, retaining its properties for long periods of time. Fire fighting foam shall flow freely over a burning liquid surface and form a tough, air-excluding continuous blanket to seal volatile combustible vapors from access to air. This foam cover shall be dense and long lasting, resisting disruption due to wind and draft, or heat and flame attack, and be capable of resealing in case of mechanical rupture.

114. CHEMICAL FOAM AND MEANS OF PRODUCING IT: Chemical foam is made by the reaction of an alkaline salt solution (usually bicarbonate of soda) and an acid salt solution (usually aluminum sulphate) to form a gas (carbon dioxide) in the presence of a foaming agent which causes the gas to be trapped in bubbles to form a tough, fire resistant foam.

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\*See Appendix, corresponding numbered paragraphs.



\*1141. **STORED SOLUTION SYSTEMS:** As in the case of the portable 2½-gallon foam extinguisher, these solutions may be made and stored separately until they are mixed when the foam is needed. Such systems may vary in size from small automatic tip-over devices to solution storage tanks of many thousands of gallons from which the solutions flow by gravity or air pressure or are pumped simultaneously to produce the foam.

\*1142. **CONTINUOUS FOAM GENERATORS:** These generators require a water supply into which dry-foam-producing chemicals are added, the generators being designed to mix the chemicals and water and produce a discharge of foam or foam solutions. There are two types of these generators. One type uses a single foam-producing dry chemical, foam being produced immediately at the generator outlet. The other type uses two dry chemicals constituting each of the two principal ingredients, the two solutions formed in this type of generator being kept separate until mixed beyond the generator.

1143. **PRESSURE TYPE FOAM GENERATORS:** These are closed devices containing the mixture of chemicals necessary for producing foam but having provision for the admission of the requisite water when foam is needed, the water valves being controlled either manually or automatically.

\*1144. **FOAM HOSE STREAMS:** Hose streams from any of these chemical foam units are provided through the use of hose and open nozzle on the discharge side.

\*1145. **FOAM POWDER:** Chemical foam powder comes in three types:

(a) Two separate dry powders, marked "A" and "B," to be mixed with water in two solution foam generators. The foam produced is suitable for fires involving ordinary hydrocarbon flammable liquids.

(b) A single blend of all the dry chemicals needed to produce foam when mixed with water, for use in single powder foam generators. Otherwise, the ingredients and use are the same as 1145 (a).

(c) A special single blend of all the dry chemicals needed to produce "alcohol" type foam when mixed with water, for use in single powder foam generators. This

foam is intended for use on fires involving water soluble solvents† such as certain alcohols (e.g., methyl, ethyl, isopropyl), esters (e.g., ethyl acetate), ketones (e.g., acetone, methyl ethyl ketone), ethers (e.g., isopropyl ether, diethyl ether), etc., which break down the ordinary foams discussed in 1141, 1145 (a), 1145 (b), and 115. It is also suitable for use on fires in liquid hydrocarbons.

†NOTE: The term "Water Soluble Solvents" refers to those liquids which, because they are wholly or partially soluble in water, or for some other reason act as "foam breakers" to destroy the foam produced by ordinary foam chemicals or ordinary air foam stabilizers. For convenience the term "water soluble solvent" will be used throughout this standard to designate materials for which "alcohol" type foam powder is required for extinguishment.

**115. AIR FOAM (Mechanical Foam) AND MEANS OF PRODUCING IT:** This type of foam is produced by the addition of a foaming agent (a liquid) to water to make it capable of foaming in the presence of air, which is usually incorporated by the mechanical action of jets in a fixed foam maker or portable playpipe. The foaming agent or air foam liquid, as it is usually called, will be referred to as "stabilizer" throughout this Standard. Ordinary air foam may not be suitable for use on fires involving water-soluble solvents (see Note 1145 (c)). However, special alcohol-type air foams are available for use on such water-soluble solvents (see A-1145 (c)). The efficiency of such "alcohol" type foams on liquid hydrocarbons may vary with different foam stabilizers and foam-making devices. For such use the recommendations of the manufacturer and the authority having jurisdiction should be followed.

**\*1151. FIXED FOAM MAKERS FOR AIR FOAM:** These are approved in a variety of sizes for the connection of water inlet pipe and foam outlet pipe. When water under pressure and containing the proper percentage of stabilizer passes through the foam maker, air is aspirated in proper amount and foam is continuously formed.

**\*1152. AIR FOAM PUMPS:** This method of producing air foam under pressure involves the use of rotary, positive-displacement pumps to automatically proportion and mix the air, water, and stabilizer. These self-contained pumps may be placed in a central pump house and the foam distributed to the protected tanks through a manifold or they may be used as portable equipment.

\*1153. **AIR FOAM HOSE STREAM NOZZLES:** An air foam nozzle is a special playpipe or nozzle incorporating a foam maker to aspirate air into the solution, thus producing air foam. These are approved in a variety of sizes and may be of a type that picks up foam stabilizer directly from a container or of a type that operates on a stream of solution consisting of water into which the stabilizer has been introduced at another point.

\*1154. **AIR FOAM STABILIZER:** Air foam stabilizer is a liquid which, depending on its concentration and nature, is used in a proportion from 3 per cent to 6 per cent in water as recommended by the manufacturer and as approved by the authority having jurisdiction. There are two fundamental types of air foam stabilizer: "low expansion," and "high expansion." Special "alcohol" type, low expansion type foam stabilizer is available according to the requirements of the particular water-soluble solvent to be protected.

NOTE: It is important that different stabilizers not be mixed unless it is known that they are compatible and suitable for the equipment available.

\*1155. **AIR FOAM SOLUTION:** Air foam solution shall be stored premixed, or a suitable approved proportioner shall be provided for continuous introduction of air foam stabilizer in adequate ratio into the water stream at or enroute to the foam maker. Air foam solution may be produced by the following means:

(a) **PREMIX METHOD.**

(1) By premixing a suitable air foam stabilizer directly into the water in a booster or other storage tank.

(b) **PROPORTIONER AT THE MAIN PUMP.**

(1) **Pump Suction Method** — By inducting the stabilizer into the water pump through a fixed or variable orifice proportioner located in the suction line of the pump.

(2) **Around-the-Pump-Proportioner** — By means of a venturi inducing proportioner located in a bypass between the pump discharge and the pump suction.

(c) **PROPORTIONER BETWEEN THE MAIN PUMP AND THE FOAM MAKER.**

(1) **Pressure Proportioning Tank Method** — By forcing stabilizer into the water stream by water displacement and venturi induction. This device is commonly

called a Proportioning Tank or Pressure Proportioner and is located between the water pump or hydrant and the foam maker or foam nozzle.

(2) In-Line Inductor — By inducting the stabilizer through approved single or multiple inductors located in the water line to the foam maker.

(3) Primary-Secondary Induction Method — By bypassing a portion of the water through a branch line containing a primary inductor to pick up the stabilizer, the entire mixture in the branch line being then inducted back into the main water line through a secondary inductor in the foam maker.

(4) Pressure Side Proportioner — By forcing stabilizer into the flowing water stream through an approved pressure side proportioner by means of a stabilizer pump.

(5) Water Motor Proportioner — By means of a displacement type stabilizer pump operated by a displacement water motor.

(d) PROPORTIONER AT THE FOAM MAKER.

(1) Single Built-In Inductor in the Foam Maker — By picking up the stabilizer from a container at atmospheric pressure by an inductor in the foam maker. In this system the foam maker may be mounted directly on the stabilizer container.

## 120. Uses and Method of Application.

121. GENERAL PURPOSES — The principal use for foam is the extinguishment of fires involving flammable liquids. It may also be used effectively to provide exposure protection and to prevent fires.

NOTE: In the absence of more suitable extinguishing media, foam may be used effectively on ordinary combustible materials (wood, paper, etc.).

1211. Extinguishment of fire by foam is accomplished primarily by the smothering action of the fluid blanket. As the foam is applied to the burning surface, it flows easily to effect a complete seal over the entire area, cutting off the oxygen, and also tends to prevent the further formation of combustible gases. The water content of the foam is extremely important in preventing breakdown of the foam by heat and in accomplishing a degree of cooling.

1212. Exposure protection of an exceptionally high order is provided by the application of foam blankets. The heat resistance of foam as defined in this standard is very high and heat transmittal is exceptionally low.

\*1213. Prevention of fire may also be provided by applying foam blankets to spills or other hazardous areas to prevent ignition.

\*122. LIMITATIONS: Foam has certain limitations of use which must be recognized (see Appendix).

### 130. System Requirements.

131. FOAM CHEMICALS — Foam-producing materials for chemical or air foam must not be readily subject to deterioration when properly stored and must produce a foam conforming to requirements of 113.

\*132. MIXING — Means shall be provided for thoroughly mixing the foam-producing materials to form a suitable foam before it reaches the surfaces to which it is to be applied. Mixing devices may be in combination with discharge outlets, with supply tanks (self-contained chemical engines) or may be separate devices.

NOTE: This does not exclude the use of some of the discharge piping to perfect the final mixing.

### 133. DISCHARGE OUTLETS.

1331. Discharge outlets shall be so provided, designed and located as to permit the delivery of the foam over the area to be protected, the distributor used being particularly adapted to the local conditions.

1332. Discharge outlets may be in combination with mixing devices or may be separate devices.

\*134. WATER SUPPLIES: All foam systems except stored solution systems depend for their successful operation upon a source of water. This shall be available at suitable pressure and quality and in adequate quantity.

1341. QUANTITY: The water supply shall be adequate in quantity to supply all the devices served in the same fire area. This includes not only the volume required for the foam apparatus but also water which may be used in other fire fighting operations, superimposed on the normal plant requirements.

Secondary water supplies available for use of fire department pumpers (and other water sources) should be considered for foam producing facilities or for water hose streams for exposure protection.

1342. **PRESSURE:** The pressure available at the inlet to the foam apparatus (foam generator, air foam maker, etc.) under required flow conditions shall be at least the minimum pressure for which the apparatus has been designed and approved. This pressure shall be measured or calculated under the duty conditions anticipated to obtain at the time of the emergency (see 1341).

1343. **QUALITY:** The water supply shall be of suitable quality so as to have no adverse effect on foam formation or foam stability. No corrosion inhibitors, freezing point depressants or any other additives should be used without prior consultation with the foam liquid or powder supplier. Use of unauthorized additives may materially reduce the effectiveness of foam systems.

\*1344. **STRAINERS:** Strainers capable of removing from the water all solids of sufficient size to obstruct openings in the foam apparatus shall be provided.

1345. **DESIGN:** The water system shall be designed and installed in accordance with principles recognized in standards for such extinguishing systems (see Appendix A-110).

(a) **HYDRANTS:** Hydrants furnishing the water supply for portable foam generators and portable air foam apparatus shall be provided in such number and be located as required by the authority having jurisdiction.

#### **140. Storage of Foam-Producing Materials.**

141. **LOCATION, BUILDING:** Where a central foam house (including foam pump house, generator house or portable equipment storage building) is provided for equipment and foam materials, the building shall be a detached, noncombustible structure situated in an accessible location not seriously exposed by the hazard it protects. Where acceptable to the authority having jurisdiction, space in an existing building may be used if the room is of fire-resistive construction with standard cutoff from all other portions of the building.

142. LOCATION, PORTABLE MATERIALS: Where the materials are entirely portable, and distributed about the premises, the authority having jurisdiction should be consulted as to location and housing. (See also 145 and 146 for additional requirements for the storage of various foam-producing materials.)

143. OFF-PREMISES STORAGE: The authority having jurisdiction may permit the storage of foam-producing materials off the premises, where these supplies are suitable for use in the equipment of the installation, and are immediately available at all times. Adequate loading and transportation facilities must be assured. Not over 50 per cent of the supplies required for the given installation may be stored off the premises. Extreme care must be exercised in making sure the off-premises supplies are of the proper type for use in the facilities of the given installation. At the time of a fire these off-premises supplies should be accumulated in sufficient quantities, before placing the equipment in operation, to insure foam production at an adequate rate without interruption until extinguishment is effected.

**\*144. WET STORAGE CHEMICAL FOAM SYSTEMS.**

1441. Where two-solution storage is used, the solutions should be stored and contained in tanks conforming to the NFPA Standard for Water Tanks for Private Fire Protection (No. 22) so far as they may apply, due consideration being given to the specific gravity of the foam-producing solutions. Metal tanks used for storing corrosive liquids shall be protected from corrosion in a reliable and permanent manner.

\*1442. Suitable provision shall be made when necessary for maintaining the supply of foam-producing solutions at temperatures that will not inhibit normal chemical action.

1443. Means should be provided for the agitation or circulation of the liquids to assure uniform solutions. "B" chemical solution should not be agitated for more than 5 minutes, nor more frequently than once a year except when adding new quantities of chemicals or water.

1444. Facilities separate from the storage tanks shall be provided for dissolving and preparing the chemicals to

permit prompt restoration of the system to operating condition after use.

NOTE: This may be accomplished by the use of generators.

\*1445. Pumps should be of a positive displacement type and shall be so arranged as to deliver the required quantities of the solutions in the proper proportions.

1446. Suitable means shall be provided for making full pump capacity tests with water.

#### 145. DRY STORAGE CHEMICAL FOAM SYSTEMS.

1451. Dry foam-producing chemicals shall be stored in approved containers in a location not subject to abnormal deterioration, subject to the approval of the authority having jurisdiction.

#### \*1452. CENTRALIZED FIXED PIPING SYSTEMS.

(a) STORAGE IN CONTAINERS OF LARGE CAPACITY: Where systems require more than 10,000 lbs. of foam-producing chemicals, it is recommended that at least 50 per cent of the entire supply of such chemicals be stored in containers of large capacity which permit of prompt and uninterrupted feeding of the generators, with a minimum of manpower. Such containers shall be of moisture-proof construction throughout to assure the storage of powder over long periods without abnormal deterioration. They may be of the fixed or movable type and shall be arranged to allow prompt and continuous flow of powder to the generators, without waste. The arrangement of powder containers and generators shall be such as to provide for easy access to powder for periodic inspection.

(b) STORAGE IN PORTABLE CONTAINERS: Such storage may be employed if sufficient manpower is available at all times to feed the generators at the rate required by the system. In many cases a local fire department may be called upon to provide the necessary manpower and water supply.

#### \*146. AIR FOAM SYSTEMS.

1461. The supply of stabilizer may be stored in the original shipping containers, in pressure proportioning tanks or in special tanks designed for the purpose. The stabilizer should not be stored at temperatures lower than



that for which it is approved nor above 120°F. It shall be stored in a location free of excessive moisture to avoid external corrosion of containers and other equipment.

## 150. Piping Installation Requirements.

### 151. MATERIALS.

1511. PIPING: Piping shall be steel, suitable for the pressure involved, but not less than standard weight, in accordance with current American Standards. Pipe specifications normal for water use shall be permitted outside the hazard or diked area.

1512. VALVES: All valves are to be of a type approved for the purpose used. Lever operated gate valves are not acceptable. Readily accessible drain valves shall be provided for low points in underground and aboveground piping. Valve specifications normal for water use shall be permitted outside the hazard or diked area.

1513. FITTINGS: All pipe fittings shall be American Standard for the pressure class involved but not less than 125 lbs. standard. Iron fittings shall be malleable in dry sections of the piping exposed to possible fire. Automatic control valves, shut-off valves and strainers of approved types may be cast iron if outside the fire area. All fittings subject to stress in self-supporting systems shall be steel or malleable iron.

152. PIPE SIZE: As effective protection depends on having an adequate volume of water (or solutions), at proper pressure, available at the foam-making apparatus, each system requires individual consideration as to the size of the piping. 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 should be so selected as to produce the proper delivery rate at the discharge outlet. Friction losses in piping carrying foam are not susceptible to simple calculation, and the recommendations of the manufacturer of the device should be followed.

153. INSTALLATION: Installation shall conform to the applicable NFPA Standards as modified herein.

**154. FLUSHING.**

**1541. UNDERGROUND PIPING:** Underground mains shall be flushed thoroughly at the maximum practicable rate of flow, before connection is made to system piping, in order to remove foreign materials which may have entered during installation. The minimum rate of flow for flushing should not be less than the water demand rate of the system which is determined by the system design and the water supply available. The flow should be continued for a sufficient time to insure thorough cleaning. In connection with flushing operations, consideration shall be given to means for disposal of the water discharged.

**1542. SYSTEM PIPING:** After installation, all system piping shall be flushed where practicable by placing the system in operation using its normal water supply, but with the foam supply shut off. Otherwise, cleanliness of the pipe interiors shall be determined during installation by visual examination.

**1543. FLUSHING AFTER USE:** Provision shall be made in the design to permit flushing with clean fresh water after use.

**155. TEST GAGE:** A test gage connection shall be provided on each side of each chemical foam generator, air foam proportioner, and system pump and at each lateral control valve.

**160. Plans and Specifications.**

**161. REQUIREMENTS:** Foam system layout and installation should be entrusted to none but fully experienced and responsible persons. Before fixed foam systems or portable equipment are installed or existing equipment re-modeled, complete working plans and specifications should be submitted for approval to the authority having jurisdiction. Any material deviation from the approved standards, will require special permission from the authority having jurisdiction. Plans shall be drawn to any indicated scale, show all essential details and shall be made so they can be easily reproduced to provide the necessary copies or prints. The authority having jurisdiction may require, for approval, tests of available water supply, complete computations showing pressure drop in all system piping, friction loss calculations on liquid lines and a detailed layout of the entire hazard to be protected.

1611. Hydraulic characteristics of foam proportioners and of foam makers as determined by tests shall be supplied by the manufacturer to the user and the authority having jurisdiction (including the range of operating conditions required for the proposed installation), to permit determination of the adequacy of the hydraulics of the proposed protection.

162. TEST RESULTS TO BE SUPPLIED: For the following equipment, equipment manufacturers shall supply test results to the owner and to the authority having jurisdiction:

1621. SINGLE LINE CHEMICAL FOAM GENERATORS:

(a) Water rate at 100 psi inlet water pressure.

(b) When operating at 100 psi inlet water pressure and water temperature at 70°F., the powder rate, foam expansion and foam quality, using the stated foam powder and delivering to the foam pipe layout given in the table under A3422, and also when delivering to the foam pipe and hose stream layout (with nozzle size stated) given in the table under A3422.

(c) If the pipe line layout differs from that specified in A3422, either by the use of longer pipe lines or by the use of pipe sizes other than those specified in A3422, or if the water rating of the generator at 100 psi inlet water pressure exceeds that specified, then test data for the proposed layout shall be obtained and submitted.

1622. CHEMICAL FOAM SOLUTION GENERATORS.

(a) Water rate at 100 psi inlet water pressure.

(b) When operating at 100 psi inlet water pressure and water temperature of 70°F., the powder rate, foam expansion and foam quality, using stated foam powder and delivering against a back pressure of 40 psi (40 per cent of the inlet water pressure).

(c) If the proposed layout will result in a back pressure in excess of 40 per cent of inlet water pressure, test data for operation against such higher outlet pressure shall be obtained and submitted.

1623. AIR FOAM.

(a) SOLUTION PROPORTIONERS. — When operating at water pressures of 50 and 100 psi on the supply side

of the proportioner the following data :

- (1) Water rate.
- (2) Solution rate.
- (3) Pressure on each side of the proportioner.

(4) Such other test data as may be required to determine the adequacy of the design of the system.

(b) FOAM MAKERS.

(1) Water rates and foam production of the foam makers at 50 and 100 psi at the foam makers.

(2) Such other test data as may be required to determine the adequacy of the design.

### 170. Approvals.

171. All plans and specifications pertinent to the installation shall be approved by the authority having jurisdiction prior to installation. The authority having jurisdiction shall be consulted as to devices and material. All equipment shall be approved for the particular application intended. Before requesting final approval of a foam system by the authority having jurisdiction, the installing company should furnish a written statement to the effect that the work has been completed and tested in accordance with approved plans and specifications.

### 180. Acceptance Tests.

181. PRESSURE TESTS: All piping except that handling expanded foam shall be subjected to a 2-hour hydrostatic pressure test at 200 lbs. per sq. in. or 50 lbs. in excess of the maximum pressure anticipated, whichever is greater, in general conformity with the NFPA Standard for the Installation of Sprinkler Systems (No. 13). All normally dry horizontal piping shall be checked to determine if proper drainage pitch is provided.

182. OPERATING TESTS: Before acceptance, fixed foam systems shall be subjected to such tests as may be required by the authority having jurisdiction. Wherever practicable these tests shall include operation of all devices and equipment installed as part of the system.

\*183. DISCHARGE TESTS: Approval and acceptance of foam systems may be subject to flow tests where conditions permit, in order to insure that the hazard is fully

protected in conformance with the design specification, and to determine the flow pressures, actual discharge capacity, foam quality, consumption rate of foam-producing materials, manpower requirements and other operating characteristics. The foam discharged from the delivery equipment (foam chamber, portable tower, pipe or nozzle) shall be of good quality as defined in 113. This Standard, to be effectively used, requires a minimum quality of foam. As a means of assuring that users of foam equipment will be able to produce foam of at least the minimum quality as defined herein, the appropriate tests from Chapter VI are suggested.

184. **VISUAL EXAMINATION:** Foam systems shall be examined visually to determine that they have been properly installed. Checks shall be made for such items as conformity with installation plans, continuity of piping, tightness of fittings, removal of temporary blank flanges, accessibility of valves and controls, and proper installation of vapor seals, where applicable. Devices shall be checked for proper identification and instructions.

#### 190. Maintenance.

191. **WATER SUPPLIES:** Proper precautions should be taken to insure that water supplies are kept turned on and are in full operating condition at all times in accordance with other standards governing water supplies for fire protection equipment.

192. **STRAINERS:** Strainers should be thoroughly inspected and cleaned after each operation or flow test. Inspection and cleaning should be performed at intervals of not more than six months.

193. **PIPING:** All piping shall be examined at regular intervals to determine its condition. The frequency of inspections will be dependent upon local conditions and should include tests to determine that proper drainage pitch is maintained for piping. Pressure tests of normally dry piping outdoors shall be made annually. At such time as hydrostatic tests are conducted on the foam piping, swing joints at the base of the tank risers shall be checked to assure that the joints still have flexibility to take care of shock and movement.

194. CONTROL VALVES AND DEVICES: Automatic control valves and heat-actuated devices shall be tested at least twice a year by qualified inspectors acceptable to the authority having jurisdiction.

NOTE: An inspection contract with the installer of the equipment for test and examination at regular periods is advisable.

1941. Manual tripping devices and valves, including O. S. and Y. gate and post indicator valves, shall be operated at least twice a year.

#### 195. SYSTEM RESTORATION AFTER USE.

1951. Where normally opened valves are closed following system operation or test, suitable procedures should be instituted to insure that they are reopened and that the system is promptly and properly restored to full normal operating condition. Drain flow tests should be made after valves are reopened.

1952. After each operation, devices mixing foam chemicals and making foam shall be cleaned and inspected.

#### 196. INSPECTION OF FOAM-PRODUCING MATERIALS.

1961. Periodic inspection should be made of stored chemicals, powder, air foam stabilizer, etc., and their containers.

197. OPERATING AND MAINTENANCE INSTRUCTIONS: Operating and maintenance instructions and layouts shall be posted at control equipment and at fire headquarters. Selected plant personnel should be trained and assigned the task of operating and maintaining the equipment.

## CHAPTER 2. FOAM SYSTEMS FOR LOCALIZED INSIDE HAZARDS, FOR ROOMS OR BUILDINGS, AND FOR SMALL OUTSIDE TANKS.

\*200. GENERAL: This Chapter relates to the class of foam fire extinguishing apparatus designed to protect: hazards located in rooms and buildings where foam protection for the hazard only is desired; or general foam protection for the contents of the room or building which may or may not include the structure. The requirements of this Chapter may also be applied to small outside tanks having a liquid surface not exceeding 200 sq. ft.

### 210. Rate of Application.

211. RATE OF APPLICATION: The rate of discharge to foam outlets protecting the hazard or area shall be at least as follows:

2111. For chemical foam systems with stored "A" & "B" solutions, a total of 1.6 gpm (0.8 gpm of "A" solution, and 0.8 gpm of "B" solution, where these solutions are intended to be mixed in equal volumes or other proportions as recommended by the manufacturer of the apparatus but totalling 1.6 gpm) for each 10 sq. ft. of surface to be protected.

2112. For dry powder foam generator systems the water rate to the generator shall be at least 1.6 gpm for each 10 sq. ft. of surface to be protected.

2113. For air foam systems the delivery rate to the foam makers shall be at least 1.6 gpm of water (including stabilizer) for each 10 sq. ft. of liquid surface area of the tanks to be protected.

2114. The minimum rate of discharge and supply of foam producing materials as required by 2112, 2211 and 2221 shall be provided for hazards involving water soluble solvents. Protection of these hazards requires the use of "alcohol" type foam (see 1145 (c), 115 and the note following 3121).

## 220. Supply of Foam-Producing Materials

### 221. FOAM SYSTEMS FOR LOCALIZED INSIDE HAZARDS AND FOR SMALL OUTSIDE TANKS.

\*2211. There shall be provided a quantity of foam-producing materials sufficient to operate the equipment at the discharge rate specified in 211 for a period of at least two minutes. Additional materials shall be provided depending upon the local conditions, such as severity of the hazard and obstructions likely to interfere with the distribution of foam. Due allowance shall be made for the amount of foam required to fill the extinguishing system and for foam, foam chemicals or stabilizer not actually distributed. The authority having jurisdiction shall be consulted in each case as to the minimum quantity of foam-producing materials required.

2212. If the tank contents are not maintained at a constant level (not lower than 5 ft. below the rim) apply the rules for outdoor storage tanks, Chapter III, and provide materials for applying foam for 20 minutes.

2213. For the protection of drainboards the above foam supply requirement may be reduced taking into consideration the nature of the operation, area of drainboard to be protected (including hanging stock), location and housekeeping. For minimum requirements the authority having jurisdiction should be consulted.

### 222. FOAM SYSTEMS FOR ROOMS AND BUILDINGS.

\*2221. There shall be provided a quantity of foam-producing materials sufficient to operate the equipment at the discharge rate specified in 211 for a period of at least three minutes. Additional materials shall be provided depending upon the local conditions, such as severity of the hazard and obstructions likely to interfere with the distribution of foam (in the construction of the building and contents). Due allowance shall be made for the amount of foam required to fill the extinguishing system and for foam not actually distributed. The authority having jurisdiction shall be consulted in each case as to the minimum quantity of foam-producing materials required.

2222. Apparatus furnishing the supply should preferably not be located in the same fire area containing the



hazard which it protects, and shall not be subject to an exposure fire in the hazard which it protects.

### 230. System Piping.

231. Piping shall be so arranged as to reduce friction to a reasonable minimum.

2311. Pipes shall be securely supported and where protecting hazards in rooms where explosions are possible, pipes should be hung from other supports than the roof so that if the roof lifts, the piping will not be broken or disarranged.

2312. Foam distribution piping shall be arranged to drain and should have a pitch toward drain  $\frac{1}{2}$  in. in 10 ft.

2313. HANGERS: All hangers must be of approved types. Tapping or drilling of load bearing structural members should not be generally permitted. Attachments may be made to existing steel or concrete structures and equipment supports. Where systems are of such a nature that the standard methods of supporting pipe for protection purposes cannot be used, the piping shall be supported in such a manner as to produce the strength equivalent to that afforded by such standard means of support.

2314. INSTALLATION: The installation standards for foam system piping shall be the applicable sections of the NFPA Standard for the Installation of Sprinkler Systems (No. 13) except as herein modified. Welding in accordance with ASA Code for Pressure Piping is permissible when it can be done without introducing fire hazards. Special care should be taken to insure that the openings are fully cut out and that no obstructions remain in the waterway. The supply piping to foam outlets which protect a hazard in a fire area shall not pass over another hazard in the same fire area.

232. Flexible hose connections shall be used only where absolutely necessary. When used, hose shall be installed and connected so as to present a minimum resistance in moving and shall have an inside diameter not smaller than the piping to which it is attached.

### 240. Discharge Outlets.

241. Discharge outlets shall be provided in such sizes,

number and locations as to meet the requirements for discharge and to distribute the foam as required by the particular hazard protected.

242. Discharge devices may be of the open type or of the closed automatic type and may be designed to form a mixer and a distributor, as well as a release device.

243. A type of discharge outlet adapted to the protection of the particular hazard shall be used. The application of foam on liquid surfaces in tanks shall avoid impinging forcibly and for this purpose, large open outlets should be used. Open pipe fittings are suitable. For application of foam on drain areas, dipped product, etc., outlets smaller than the distribution piping are employed to give higher velocity of discharge. Such smaller outlets should be specifically designed by the foam manufacturer for the specific system so that the distribution of foam will be accurate and foam quality satisfactory.

244. Where branch lines are employed to carry foam from a central header to a number of foam outlets, the central header should have ample capacity to supply all outlets and the branches should be designed to assure uniform foam distribution.

## **250. Operation and Control of Automatic Foam Systems.**

\*251. Where automatic controls are provided to start the water flow to a foam device, controls shall also be provided for stopping the water flow after the completion of the foam discharge except in those cases where the authority having jurisdiction shall find that other arrangements have been made to suitably dispose of excess water. Suitable overflow facilities should be provided to maintain a constant freeboard of not less than 2 in. or 4 in. in case of tanks over 25 sq. ft. in area. (See NFPA Standard for Dip Tanks (No. 34).)

252. Manual tripping devices shall be provided for all automatic control valves. Such tripping devices shall be so located as to be readily accessible in the event of fire or possibility of fire. They shall be plainly marked to indicate their purpose.

253. Manual devices may actuate the automatic control valve by mechanical or other approved means. If a

remotely located manual device is mechanically operated, the device shall be amply strong to prevent breakage and shall require a pull not exceeding 50 lbs.

254. It is recommended that other fire protection devices have releases independent of the foam releases.

255. Control of automatic releases for foam systems shall be accomplished by methods recognized in the standards for other extinguishing systems. Systems which depend for operation on electric thermostats, relays, circuits or other similar equipment should be so arranged that such equipment is normally energized or completely supervised in a manner that failure will result in positive audible notification of the abnormal condition. Pneumatic release (rate-of-rise) operated systems should likewise be supervised in a manner such that positive audible notification will be given of service interruption.

2551. The supervision of the fire detection and releasing system may be required by the authority having jurisdiction if the hazard protected or the values involved are judged sufficiently serious to require supervision.

NOTE: For standards applicable to: control of automatic releases for other extinguishing systems; automatic fire detection and supervisory signaling systems; see standards of National Fire Protection Association for:

Carbon Dioxide Extinguishing Systems (No. 12)

Sprinkler Systems (No. 13)

Water Spray Systems (No. 15)

Foam-Water Sprinkler and Foam-Water Spray Systems (No. 16)

Dry Chemical Extinguishing Systems (No. 17)

Central Station Protective Signaling Systems (No. 71)

Proprietary, Auxiliary, and Local Protective Signaling Systems (No. 72)

Remote Station Protective Signaling Systems (No. 72C)

## 260. Manually Operated Systems.

261. Manually operated systems shall be installed in conformity with all of the requirements of the standards for automatic systems, except that the system will be put into operation (and, if necessary, shut off) by manual

mechanisms. These may be installed in those cases where the protected area presents a hazard during working hours which is substantially relieved during nonworking hours; or where an alarm and watch system gives practical assurance of personnel being available to operate the system in an emergency. Permission for the use of manual systems must be obtained from the authority having jurisdiction.

262. The controls for manually operated systems shall be located in an accessible place, sufficiently removed from the hazard so that they may be safely operated in an emergency. The location and purpose of the controls shall be plainly indicated.

#### **270. Alarms.**

271. Automatic alarms shall be provided if required by the authority having jurisdiction, these to operate simultaneously with the release devices or with the automatic action of the means of supply.

#### **280. Foam Equipment — Hand Operated.**

281. First aid extinguishers shall be provided as required by the NFPA Standard for Portable Fire Extinguishers (No. 10). For large or severe risks, foam hose lines should be provided in accordance with Chapter V hereof.

## CHAPTER 3. PROTECTION OF OUTDOOR STORAGE TANKS BY FIXED FOAM DISCHARGE OUTLETS.

\*300. GENERAL: This chapter contains requirements, in addition to those given in Chapter I, which apply specifically to the several types of foam systems used for the protection of outdoor storage tanks containing flammable liquids by means of fixed foam discharge outlets.

### 301. DEFINITIONS.

3011. FIXED FOAM DISCHARGE OUTLET: A device permanently attached to a tank by means of which foam is introduced into the tank.

Note: For Portable Foam Towers see Chapter IV.

\*3012. TYPE I DISCHARGE OUTLET: An approved discharge outlet which under severe service conditions will conduct and deliver foam directly onto the surface of the burning liquid without undue submergence or undue agitation of the surface of the liquid.

\*3013. TYPE II DISCHARGE OUTLET: An approved discharge outlet not supplemented with means for delivering foam on the surface of the burning liquid without undue submergence or undue agitation of the surface of the liquid.

\*3014. 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 shall be permanently installed.

### \*3015. SEMI-PORTABLE INSTALLATIONS.

(a) The type in which tanks are equipped with fixed discharge outlets and piping which terminates at a safe distance from the tanks. The fixed piping installation 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.

(b) The type in which the foam-producing solutions are piped from a central foam house through the area, the solution being delivered through hose lines to portable foam towers which are erected after the fire starts (see Chapter IV); or applied by hose streams (see Chapter V).

### 310. Rate of Application.

The minimum rate of discharge to foam discharge outlets protecting an individual tank shall be as follows:

#### \*311. TO TANKS CONTAINING LIQUID HYDROCARBONS.

3111. For chemical foam systems with stored solutions, 0.5 gpm of "A" solution and 0.5 gpm of "B" solution for each 10 sq. ft. of liquid surface area of the tank protected.

3112. For dry powder foam generator systems the water rate to the generators shall be at least one gpm for each 10 sq. ft. of liquid surface area of the tank to be protected.

3113. For air foam systems the delivery rate to the foam makers shall be at least one gpm of water (including stabilizer) for each 10 sq. ft. of liquid surface area of the tank to be protected.

3114. For highly volatile materials such as casing-head gasoline (25 to 40 lbs. Reid vapor pressure), higher rates of application are required, possibly as high as double the rates specified in 3111, 3112 and 3113.

#### \*312. TO TANKS CONTAINING CERTAIN WATER SOLUBLE SOLVENTS.

TYPE OF LIQUID	Water Rate gpm/ 10 sq. ft.
Products such as methyl, ethyl and isopropyl alcohols, ethyl acetate, etc. ....	1.0
Products such as isopropyl, ether, etc. ....	1.3
Products such as diethyl ether, etc. ....	2.7

3121. Protection of these water soluble solvents requires the use of alcohol type foam (see 1145 (c)).

NOTE: The solvent and fire resistance of "alcohol" type mechanical foam may be adversely affected by such factors as excessive pre-mix time, the use of foam-making devices not specifically designed or adequately tested for a particular "alcohol" foam application, low operating pressures, failure to maintain proportioning within the recommended concentration limits, the method of application, and the characteristics of the particular solvent to which it is to be applied.

Premix times, that is the elapsed time between injection of the foam stabilizer into water and the induction of air, may be

limited, depending on the characteristics of the foam stabilizer, the water temperature, and the nature of the hazard protected. The maximum pre-mix time on each specific installation should be within the limits established by the manufacturer. In general, foam application methods other than gentle are not satisfactory. "Alcohol" foam systems require special engineering consideration. Conditions other than routine may require that higher application rates be used. Some solvents under conditions pertaining to their storage or their use may require specific fire tests. *In all cases the manufacturer of the foam stabilizer and the foam-making equipment should be consulted as to limitations and for specific recommendations.*

### 320. Supply of Foam-Producing Materials.

**\*321. GENERAL:** There shall be stored, available for use in any fire emergency, a supply of foam-producing materials (solutions, powders, or stabilizer) adequate to accomplish the extinction of any probable fire under normal circumstances; to extinguish exposure fires likely to occur; to provide foam hose streams; to fill all necessary lines, and to assure some residual quantity after the emergency and until a complete re-order of supplies can be obtained.

**3211.** The minimum total supplies to be maintained shall be the sum of the quantities defined in 322, 3232 and 324.

**322. LIQUID HYDROCARBONS, WATER SOLUBLE SOLVENTS:** The foam-producing materials provided shall be sufficient to permit operation of the apparatus at the delivery rate specified in 310 for the following minimum periods of time:

LIQUID HYDROCARBONS	TYPE OF FOAM DISCHARGE OUTLET*	
	TYPE I	TYPE II
Lubricating oils; dry viscous residuum (more than 50 seconds Saybolt-Furol at 122°F.); dry fuel oils, etc., with flash point above 200°F. ....	15 min.	25 min.
Kerosene; light furnace oils; Diesel fuels, etc., with flash point over 110°F. to 200°F. ....	20 min.	30 min.
Gasoline; naphtha, benzol, and similar liquids with flash point below 110°F. ....	30 min.	55 min.
All crude petroleums ....	30 min.	55 min.

\*See §§3012 and 3013 for definitions.

<b>WATER SOLUBLE SOLVENTS</b>	<b>TYPE OF FOAM DISCHARGE OUTLET TYPE I</b>
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Products such as methyl, ethyl and isopropyl alcohols, ethyl acetate, etc. ....	20 min.
Products such as isopropyl ether, etc. ....	20 min.
Products such as diethyl ether, etc. ....	25 min.

NOTE: 1) If the apparatus available has a delivery rate higher than that specified in 310 proportionate reduction in the time figures may be made. Tanks containing flammable liquids having a flash point of 150° F. closed cup or higher are not, as a rule, required to be protected by foam. Foam protection for higher flash flammable liquid tanks may be desirable where abnormal situations exist, such as storage of high value stocks or liquids heated above their flash point.

NOTE: 2) In general, "alcohol" type foams require gentle application and cannot be discharged through Type II outlets.

**3221. DRY POWDER GENERATORS:** For the purpose of Section 320 it shall be assumed that dry powder generators (dual or single powder type) consume 1.25 lbs. of powder per gallon of water. Where "listings" of dry powder generators and powder by nationally recognized testing laboratories show powder consumption less than 1.25 lbs. per gallon of water, such lower figure may be used when the generator is used in the manner on which the listing was based.

### 323. FOAM HOSE STREAMS.

**\*3231.** Approved foam hose stream equipment shall be provided in addition to tank foam installations as supplementary protection for ground fires. The minimum number of hose streams required shall be as specified in 3232. For the purpose of this requirement, the equipment for producing foam hose streams shall have a water rate (or solution rate) of at least 50 gpm. Hose stream delivery quantities shall be in addition to quantities required for tank areas.

**3232.** Additional foam-producing materials shall be provided to permit operation of the hose stream equipment simultaneous with tank foam installations specified for the period set forth in the following table:



LARGEST TANK DIAMETER	MINIMUM NUMBER OF HOSE STREAMS REQUIRED	MINIMUM OPERATING TIME*
up to 35 ft. ....	1	10 min.
over 35 to 65 ft. ....	1	20 min.
over 65 to 95 ft. ....	2	20 min.
over 95 to 117 ft. 6 in. ....	2	30 min.
over 117 ft. 6 in. ....	3	30 min.

\*Based on simultaneous operation of the minimum number of hose streams required and of the size specified in 3231. Adjustment may be made where streams of greater capacity are provided.

NOTE: In the case of "alcohol" type mechanical foam stabilizers, pre-mix time limitations may require the use of separate water and foam stabilizer lines and that introduction of the foam stabilizers be accomplished close to the foam maker rather than in the central foam house. For portable applications the use of a playpipe inducing liquid from a container close to the playpipe is recommended.

324. REQUIREMENTS TO FILL PIPE LINES: A quantity of foam-producing materials sufficient to produce foam or foam 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 foam-producing material is depleted and, thus, displace the solution or foam from the lines to the tank, no added quantity is required by this paragraph.

### 330. Foam Discharge Outlets.

331. FIXED DISCHARGE OUTLETS: For the protection of quantities of flammable liquids contained or confined in a definite area (such as a storage tank) foam discharge outlets shall be attached to the container in such number and size as to deliver foam on the burning liquid surface at a rate to meet the requirements of 310.

\*3311. Tanks shall be provided with approved discharge outlets as set forth below:

LARGEST TANK DIAMETER (Or Equivalent Area)	MINIMUM NUMBER DISCHARGE OUTLETS
Up to 80 ft. ....	1
Over 80 to 117 ft. 6 in. ....	2
Over 117 ft. 6 in. to 140 ft. ....	3
Over 140 to 160 ft. ....	4
Over 160 to 180 ft. ....	5
Over 180 to 200 ft. ....	6

NOTE: It is suggested that for tanks above 200 ft. diameter, at least one additional discharge outlet be added for each additional 5,000 sq. ft. of liquid surface area or part thereof. Since there has been no experience with foam application to fires in oil tanks over 140 ft. diameter, requirements for foam protection on tanks above this size are based on extrapolation of data from successful extinguishments in smaller tanks.

3312. Fixed discharge outlets shall be installed with pipe connections designed to permit the movement or distortion resulting from fire and explosion without disarranging the device.

3313. Fixed discharge outlets shall be securely attached to the tank shell, so located and connected as to preclude the possibility of the tank contents overflowing into the foam system lines. They shall be securely attached so that displacement of the roof is not likely to subject them to serious injury.

332. VAPOR SEAL: In tanks containing liquids subject to evaporation during storage, fixed outlets shall be provided with an effective and durable seal, frangible under low pressure, to prevent entrance of vapors into outlets and pipe lines.

3321. Fixed outlets shall be provided with suitable inspection means to permit proper maintenance and for inspection and replacement of vapor seals.

\*333. FLOATING ROOF TANKS: Fixed outlets are not required on floating roof tanks. These tanks have had 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 accessibility for fire fighting crews. A suggested method for providing fixed foam systems for floating roof tanks will be found in the Appendix.

334. SUBSURFACE APPLICATION: Reports have been published relating to the subsurface application of air foam. (NFPA *Quarterly*, April, 1946.) Complete field engineering data are not available at the present time for inclusion of this method of tank fire protection.

335. **PORTABLE TOWERS:** It is desirable 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 (see Chapter IV).

336. **PRESSURE TANKS:** Fixed outlets are not required on horizontal tanks or pressure tanks operating at 1 lb. per sq. in. or higher pressure.

340. **Piping.** (See also 150.)

341. **GENERAL:**

3411. 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.

3412. Piping, except suction pipe and in other special cases where permitted by the authority having jurisdiction, shall be normally empty, being filled in case of fire, or for tests.

3413. Piping which is normally filled with liquids, such as the suction pipes, shall be protected from freezing when necessary.

3414. Piping and valves normally in contact with corrosive liquids shall be of corrosion resistant metal or reliably and permanently protected against corrosion.

3415. Pipes should be arranged to drain (pitch  $\frac{1}{2}$  in. in 10 ft.) to as few low points as possible and drains shall be provided at each of these low points.

3416. A suitable swing joint of approved ductile or standard weight malleable iron or steel fittings, or other suitable means, shall be provided at the base of tank risers to take care of shock and expansion. Where tank risers of pipe sizes 4 in. or greater are used, an alternate arrangement to the swing joints would be to weld the risers 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. At least one flanged or union joint shall be provided in each riser within 5 ft. of the ground to permit hydrostatic testing up to this joint.

3417. In systems with semi-portable equipment, the foam or solution laterals shall terminate in connections for the portable units which are at a safe distance from the tanks, outside of dikes and at least 50 ft. from tanks of 50 ft. 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.

### 342. PIPE LINES CARRYING FOAM.

\*3421. Pipe lines carrying chemical or air foam shall be of such sizes and lengths as to deliver on the surface protected the required quantity of foam of standard quality. The size, length, and location of such foam lines shall be subject to approval of the authority having jurisdiction.

\*3422. Single line chemical foam generator systems can frequently be designed to function satisfactorily when generators are supplied with water at 50 lbs. indicated flow pressure. Indicated flow pressures of 75 to 100 lbs. per sq. in. are preferable and should be provided. The sizes and length of discharge line used beyond the generator should be in accordance with the conditions under which the device has been tested and listed by nationally recognized testing laboratories.

### 343. AIR FOAM SYSTEMS.

\*3431. Usual practice involves placing an air foam maker on the tank wall at or below the top angle and feeding a mixture of water and foam stabilizer under pressure to it. The admixture of foam stabilizer may be accomplished by any of the methods enumerated in 1155. The point at which the stabilizer is added to the water makes no difference in the foam formation.

3432. The introduction of foam stabilizer may be accomplished in a central foam house and valved branch lines extended to all protected tanks.

3433. Feed lines for the foam makers at the tank may terminate outside the dike or other safe location, provision being made to supply water at proper pressure and stabilizer to proportioning equipment, etc., so that a solution of water and stabilizer can be delivered through hose to these lines.

3434. Air foam pumping units or high back-pressure types of foam makers may be installed at distances up to 600 ft. from the protected tank and will deliver air foam under pressure through 4 in. or 6 in. pipe to a foam outlet at the top angle.

**350. Valves.** (See also 1512.)

351. All valves, except hydrant valves, shall be of the O.S. and Y. or post indicator type.

352. The laterals to each foam chamber shall be separately valved in fixed installations (see 3014).

353. 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 normally closed, clearly marked, and the proper valves opened only in the fire emergency.

354. Control valves shall be located outside dikes and not less than the following distances from the shell of the tank which they control: 50 ft. for tanks less than 50 ft. in diameter; one diameter for tanks 50 ft. 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.

355. Where two or more chemical foam generators are installed in parallel discharging into the same outlet header, check valves shall be provided between each generator outlet and the header. The water line to each chemical foam generator inlet should be separately valved.

**360. Hydrants.**

361. Centralized fixed piping systems should be provided with hydrant outlets for foam hose streams for supplementary use on ground fires, supplying portable towers, etc. In lieu of foam (or solution) hydrants, water hydrants and portable generators or other devices acceptable to the authority having jurisdiction may be provided.

## CHAPTER 4. PROTECTION OF OUTDOOR STORAGE TANKS BY PORTABLE TOWER SYSTEMS.

400. GENERAL: This chapter relates to those systems in which the foam is applied through approved portable towers, which with powder, generators, hose connections, etc., in the case of dry chemical systems, or liquid foam stabilizer, proportioning devices, etc., in the case of air foam systems are placed in operating position after the fire starts. Towers may also be used with wet storage systems.

NOTE: Generally, portable towers are to be regarded as limited in scope because they cannot be utilized under all circumstances. Portable tower systems require an adequate number of men to place and maintain the apparatus in operation; and in some cases special truck units for the ready transportation of the equipment to the location of the fire. The adequacy of a portable tower system is subject to the approval of the authority having jurisdiction and his approval shall be based upon the number and availability of the men and equipment to extinguish a possible fire. On tanks over 200 ft. diameter, the use of portable foam towers may not be practical, due to the amount of equipment and number of men needed to meet requirements.

### 401. DEFINITIONS:

\*4011. PORTABLE FOAM TOWER: A device for delivering foam to the burning surface of a tank, which is brought to the scene of the fire, erected and placed in operation after the fire starts. Portable foam towers may be equipped with either Type I or Type II discharge outlets.

4012. COMPLETELY PORTABLE INSTALLATIONS: The type in which the foam apparatus, foam-producing materials, hose, etc., are transported to the scene after the fire starts, the foam being delivered to the tank by portable foam towers or by hose streams (see Chapter V).

### 410. Rate of Application.

The minimum rate of discharge to portable foam towers shall be as specified in 310.

411. FOR THE PROTECTION OF TANKS CONTAINING LIQUID HYDROCARBONS: as specified in 3111, 3112, 3113 and 3114.

412. FOR THE PROTECTION OF TANKS CONTAINING WATER SOLUBLE SOLVENTS: as specified in 312.

**420. Supply of Foam-producing Materials.** (See also 131 and 132.)

**421. GENERAL:** The minimum total supplies to be maintained shall be the sum of the quantities defined in 422, 423 and 424.

**422. LIQUID HYDROCARBONS, WATER SOLUBLE SOLVENTS:** The foam-producing materials provided shall be sufficient to permit operation of the apparatus at the delivery rate specified in 410 for the following minimum periods of time: (See also A-312.)

LIQUID HYDROCARBONS	TYPE OF PORTABLE FOAM TOWER*	
	Type I	Type II
Lubricating oils; dry viscous residuum (more than 50 seconds Saybolt-Furol at 122°F.); dry fuel oils, etc., with flash point above 200°F. ....	25 min.	35 min.
Kerosene; light furnace oils; Diesel fuels, etc., with flash point over 110°F. to 200°F. ....	30 min.	50 min.
Gasoline; naphtha, benzol, and similar liquids with flash point below 110° F. ....	55 min.	65 min.
All crude petroleums .....	55 min.	65 min.

\*See 3012 and 3013 for definitions.

#### WATER SOLUBLE SOLVENTS

Products such as methyl, ethyl and isopropyl alcohols, ethyl acetate, etc. ....	30 min.
Products such as isopropyl ether, etc. ....	30 min.
Products such as diethyl ether, etc. ....	55 min.

NOTE: 1) If the apparatus available has a delivery rate higher than that specified in 310 proportionate reduction in the time figures may be made. Tanks containing flammable liquids having a flash point of 150° F. closed cup or higher are not, as a rule, required to be protected by foam. Foam protection for higher flash flammable liquid tanks may be desirable where abnormal situations exist, such as storage of high value stocks or liquids heated above their flash point.

NOTE: 2) In general, "alcohol" type foams require gentle application and cannot be discharged through Type II outlets.

4221. **DRY POWDER GENERATORS:** For the purpose of Section 420 it shall be assumed that dry powder generators (dual or single powder type) consume 1.25 lbs. of powder per gallon of water. Where "listings" of dry powder generators and powder by nationally recognized testing laboratories show powder consumption less than 1.25 lbs. per gallon of water such lower figure may be used when the generator is used in the manner on which the listing was based.

423. **FOAM HOSE STREAMS:** The requirements for hose streams shall be as specified in 323.

424. **REQUIREMENTS TO FILL PIPE LINES:** These shall be the same as specified in 324 if applicable.

#### 430. Number of Foam Towers Required.

\*431. Towers shall be available in the proper number and size as to deliver foam on the burning liquid surface at a rate to meet the requirements of 410.

4311. Approved foam towers shall be available for tanks as set forth below:

<b>LARGEST TANK DIAMETER (Or Equivalent Area)</b>	<b>MINIMUM NUMBER FOAM TOWERS</b>
Up to 80 ft. ....	1
Over 80 to 117 ft. 6 in. ....	2
Over 117 ft. 6 in. to 140 ft. ....	3
Over 140 to 160 ft. ....	4
Over 160 to 180 ft. ....	5
Over 180 to 200 ft. ....	6

NOTE: Since there has been no experience with foam application to fires in oil tanks over 140 ft. diameter, requirements for foam protection on tanks above this size are based on extrapolation of data from successful extinguishments in smaller tanks.



## CHAPTER 5. PROTECTION OF OUTDOOR STORAGE TANKS BY PORTABLE FOAM HOSE STREAMS.

\*500. GENERAL: This Chapter relates to systems in which the foam is applied through portable foam hose nozzles.

\*501. SCOPE: Foam hose streams are usually recommended as auxiliary protection in conjunction with fixed piping systems and portable towers as specified in 323 and 423. In some cases, however, they are suitable when used alone as in protection of horizontal cylindrical tanks, floating roof tanks, and vertical tanks not over 30 ft. diameter nor over 20 ft. high. This section covers those applications where portable foam hose streams are used as primary protection.

### 510. Rate of Application.

The minimum rate of discharge from foam hose streams protecting vertical tanks shall be as follows:

#### 511. FOR LIQUID HYDROCARBONS.

5111. For chemical foam systems with stored solutions, 0.8 gpm of "A" solution and 0.8 gpm of "B" solution for each 10 sq. ft. of liquid surface area to be protected.

5112. For dry powder foam generator systems the water rate to the generator shall be at least 1.6 gpm for each 10 sq. ft. of liquid surface area to be protected.

5113. For air foam systems the delivery rate to the foam makers shall be at least 1.6 gpm of water (including stabilizer) for each 10 sq. ft. of liquid surface area of the tanks to be protected.

5114. For highly volatile materials such as casing-head gasoline (25 to 40 lbs. Reid vapor pressure), higher rates of application are required, possibly as high as double the rates specified in 5111 and 5112.

#### 512. FOR WATER SOLUBLE SOLVENTS.

5121. "Alcohol" type foams in general cannot be applied effectively through foam hose streams to outdoor storage tanks. Foam hose streams utilizing "alcohol" type foam should, in general, be limited to applications where

the foams can be pushed gently over the liquid surface to produce reasonably gentle application.

## 520. Supply of Foam-Producing Materials. (See also 131 and 322.)

521. **LIQUID HYDROCARBONS:** The quantity of foam-producing materials provided shall be sufficient to permit operation of the apparatus at the delivery rates set forth in 510 for the following minimum periods of time.

### LIQUID HYDROCARBONS

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 point over 110° F. to 200° F. ....	50 min.
Gasoline; naphtha, benzol, and similar liquids with flash point below 100° F. ....	65 min.
All crude petroleums .....	65 min.

5211. **DRY POWDER GENERATORS:** For the purpose of Section 520 it shall be assumed that dry powder generators (dual or single powder type) consume 1.25 lbs. of powder per gallon of water. Where "listings" of dry powder generators and powder by nationally recognized testing laboratories show powder consumption less than 1.25 lbs. per gallon of water, such lower figure may be used when the generator is used in the manner on which the listing was based.

5212. In plants where only horizontal cylindrical, floating roof or pressure tanks (e.g., spheroids) are in service a quantity of foam-producing materials sufficient to permit operation of the equipment specified in 532 for a period of at least 30 min. shall be provided.

## 530. Number of Foam Hose Streams.

\*531. Foam hose streams shall be available in the proper number and capacity as to deliver foam on the burning liquid surface of a vertical tank at a rate to meet the requirements of 510. Additional foam hose streams and required equipment shall be provided as supplemental protection for ground fires in accordance with 3231 and 3232.

532. In plants where only horizontal cylindrical, floating roof or pressure tanks (e.g., spheroids) are in service, the following minimum number of foam hose streams shall be provided. For the purpose of this requirement, the equipment for producing foam hose streams shall have a water rate (or solution rate) of at least 50 gpm. For tanks less than 65 ft. diameter: 1 hose stream. For tanks 65 ft. in diameter and larger: 2 hose streams. Where more than one horizontal tank is enclosed by a single dike, and the aggregate capacity of the tanks exceeds 35,000 gals. at least two foam hose streams shall be provided.

533. The size of air foam nozzles, nozzles and mixing sets for chemical foam, and similar auxiliary equipment shall be as specified by the manufacturer and used in accordance with the instructions of the manufacturer.

#### 540. Operating Tests.

541. Manufacturers shall report test results to users and the authority having jurisdiction as follows:

5411. Water rate to single powder foam generators at 50, 75, and 100 psi flowing pressure, and powder rate and foam production rate (measured after good foam is discharged from the nozzle) using stated powder delivering through 100 ft. of 2½-in. hose and stated nozzle, and foam stream range with water at 70°F.

5412. For foam solution generators, test similar to 5411, but with twin 2½-in. solution lines 200 ft. long to stated mixing nozzle set, and additional data to include pressure on generator outlet and at the inlet to the mixing nozzle set.

#### 550. Unlined Fabric Hose.

551. Unlined fabric hose shall not be used with foam equipment.

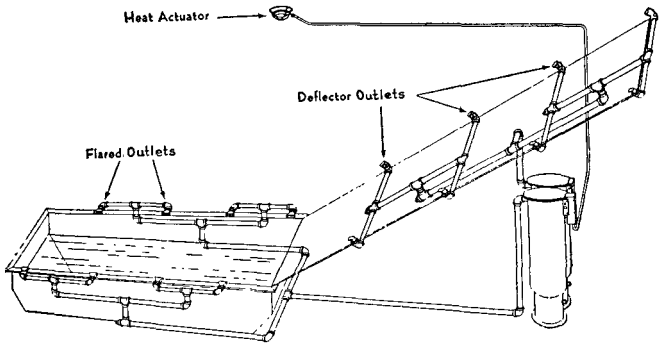
## CHAPTER 6. TESTS FOR THE PHYSICAL PROPERTIES OF FOAM

\*600. GENERAL: This chapter relates to the testing of foams for their physical characteristics when it is desired to estimate their fire extinguishing properties or check the operating conditions of foam systems.

\*601. SCOPE: The Appendix material contains detailed procedures for the sampling and analysis of fire fighting foams. An attempt has been made to accommodate all the presently used methods of foam application.

## APPENDIX

## A-1141. STORED SOLUTION SYSTEMS:



**Fig. A-1141.** An automatic chemical foam system of the stationary unit type protecting a dip tank and drain board.

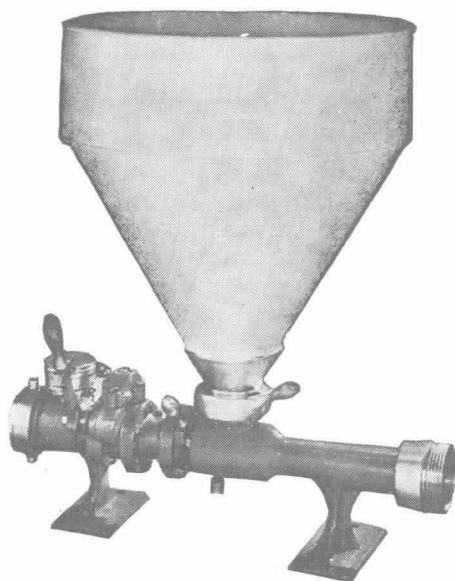
In the case of stored solution systems, where the acid solution ("A" solution) and bicarbonate solution ("B" solution) are properly prepared for use in equal volumes, 0.5 gal. of "A" solution plus 0.5 gal. of "B" solution (a total of one gallon of solutions) produces about eight gals. of foam.

**A-1142. CONTINUOUS FOAM GENERATORS:** Figures A-1142A and A-1142B show the two types of chemical foam generators.

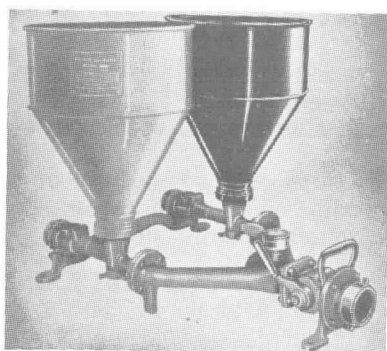
The water pressure at the inlet to the generator should preferably be between 75 and 125 psi. Operation is, however, possible with a minimum of 50 psi at the generator inlet.

The back pressure created by hose or piping attached to the discharge side of the generator should not exceed 40 per cent of the generator inlet pressure.

**A-1144. FOAM HOSE STREAMS:** Ample hose should be provided for foam development. The nozzle throat sizes are much larger than those commonly used for water. The manufacturer should state the correct size and length of hose and size of nozzle for each chemical foam unit.



**Fig. A-1142A.** Single hopper chemical foam generator of the single powder type.



**Fig. A-1142B.** Dual hopper chemical foam generator of the two powder type.

Where water temperatures are less than 50°F., the mixing tubes used with two powder generators should be increased in length to conform with the recommendations of the manufacturer. Similarly, the length of hose used on the discharge side of single powder generators should likewise be increased. The size of nozzle tip used should also be as recommended by the manufacturer.

#### A-1145. FOAM POWDER.

A-1145 (a). Dual foam powder produces 8 to 12 gals. of foam per pound of powder consumed, depending on the apparatus used and the conditions of use. Modern dual generators produce from 11 to 16.5 gals. of foam per gallon of water consumed. (See Notes 1 and 2, A-1145 (c).)

Dual foam powder is packed in pails containing approximately 50 lbs. The pails are distinctly marked with the letters "A" and "B."

Powder pails should be stored in a dry place and kept painted to prevent perforation of the container by corrosion with attendant deterioration of the contents. Powder should not be exposed to excessively high temperatures, preferably, not over 100°F., to prevent deterioration of the powder within the pail.

The entire stock of pails should be restacked every six months and the pails turned over (i.e., inverted with respect to their former position) to prevent compacting of the powder. This is particularly important where the stocks are subject to vibration.

A-1145 (b). Single foam powder produces 7 to 11.5 gals. of foam per pound of powder consumed, depending on the apparatus used and the conditions of use. Modern single powder generators produce from 10 to 19.5 gals. of foam per gallon of water consumed. (See Notes 1 and 2, A-1145 (c).)

Single powder is packed in 50-lb. pails which are distinctively marked. The precautions given in A-1145 (a) also apply to single powder chemicals.

A-1145 (c). The special foam powder produces 5 to 7.5 gals. of foam per pound of powder consumed depending on the apparatus used and the conditions of use. Modern single powder generators using this material produce from 6.5 to 11.5 gals. of foam per gallon of water consumed. (See Note 2 under the following table.)

This special foam powder is effective on fires involving water soluble solvents among which are the following:

<i>Alcohols</i>	<i>Ethers</i>
Methyl alcohol	Ethyl ether
Ethyl alcohol	Isopropyl ether
Propyl alcohols	Amyl ether
*Butyl alcohols	Dioxane
*Diacetone alcohol	Ethyl Cellosolve
<i>Esters</i>	Butyl Cellosolve
Methyl acetate	*Carbitol
Ethyl acetate	*Butyl Carbitol
	<i>Ketones</i>
	Acetone
	Methyl ethyl ketone

\*These represent borderline cases in which the material destroys ordinary foam to some extent. A higher than usual rate of regular foam application is necessary to achieve effectiveness ordinarily encountered on petroleum products.

Ordinary foam powder is suitable for use on fires involving iso-octyl alcohol.

Where materials other than those listed require protection, the manufacturer of foam-producing materials should be consulted as to type of foam and rate of application necessary to secure extinguishment.

The precautions given in A-1145 (a) also apply to the "alcohol" type foam chemicals.

NOTE: 1. The foam produced by the powders referred to in A-1145(a) and A-1145(b) disintegrates rapidly when applied to most water soluble solvents such as certain alcohols, ketones, ethers, etc., and is not considered effective in the extinguishment of fires involving these liquids.

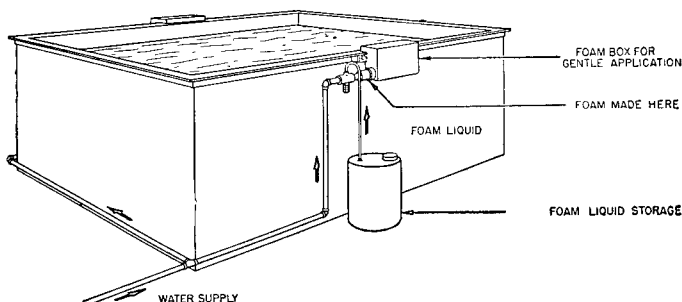
NOTE: 2. Foam expansion depends on a number of factors, among which are:

- a — Type of foam powder.
- b — Water temperatures.
- c — Atmospheric temperatures.

The values given above are for water temperatures between 50° and 70° F. Low water temperatures retard the chemical reaction. Warm water may result in higher expansion at the expense of the quality of the foam.

A-1151. FIXED FOAM MAKERS FOR AIR FOAM: In installations such as dip tanks, quench tanks, etc., as illustrated below, the foam maker may be installed in connection with a vessel of stabilizer from which the stabilizer is drawn by the flowing water passing through the foam maker. Such devices may be automatically or manually operated by controlling a single valve.



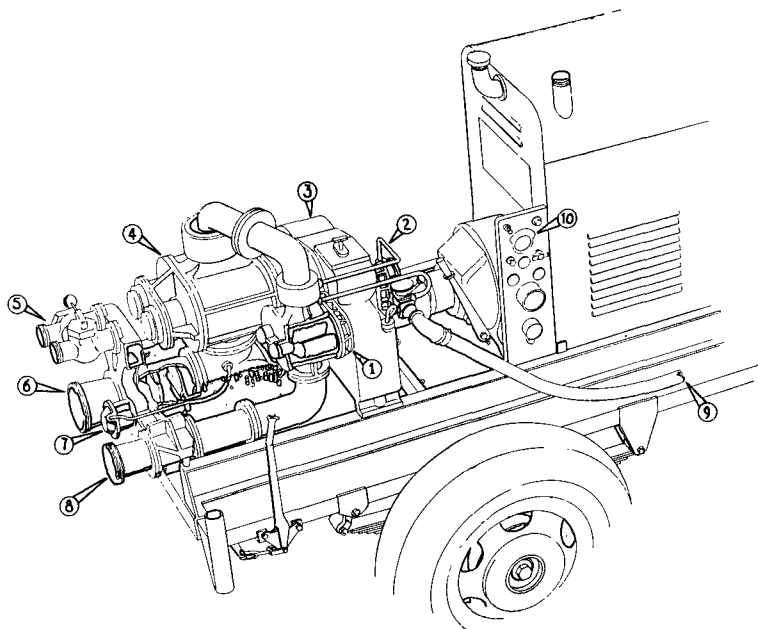


**Fig. A-1151. Schematic diagram showing protection of dip tanks with air foam system. Foam liquid (stabilizer) storage in vessel beside dip tank.**

**A-1152. AIR FOAM PUMPS:** Fig. A-1152 illustrates a pressure foam pump. This is a truck or trailer mounted unit driven by a gasoline engine. It consists of three positive displacement rotary pumps whose discharge capacities are proportioned to one another. These pumps are driven through suitable gears from the same shaft. Water is admitted at (8) to the water pump (1). Air foam stabilizer is drawn through hose (9) by pump (2) and delivered to the discharge side of the water pump. The mixture of water and stabilizer is directed to the open suction of a churn pump (4) having a nominal capacity of 2,000 gpm. This pump also draws in air through the open suction and the mixture of air, water and stabilizer is converted to a homogeneous mixture of air foam in the pump and discharged through outlet (6) or through the two 2½-in. hose connections (5).

This machine delivers foam through the foam outlet or the 2½-in. hose connections at any pressure up to 60 psi, and its operation is practically independent of pressure variations in the lines or in the water suction inlet. It delivers from 500 gpm to 2,000 gpm of foam at a constant expansion of 4.

**LIMITATIONS:** This air foam pump will stall if operated with all outlets closed. The pressure available at the foam discharge depends on the speed at which the engine



**Fig. A-1152. Air Foam Pump.**

(1) Water Pump, (2) Stabilizer Pump, (3) Gear Box, (4) Churn Pump, (5) two 2½-in. Hose Connections, (6) 6-in. Hose Connection, (7) Pressure Control, (8) 4½-in. Water Inlet, (9) Hose Connection to Stabilizer Container, (10) Tachometer on Control Panel.

is operated which in turn controls the volume of foam delivered; e.g., at the minimum output rate of the device (500 gpm) only about 40 psi foam pressure is available.

**A-1153. AIR FOAM HOSE STREAM NOZZLES:**



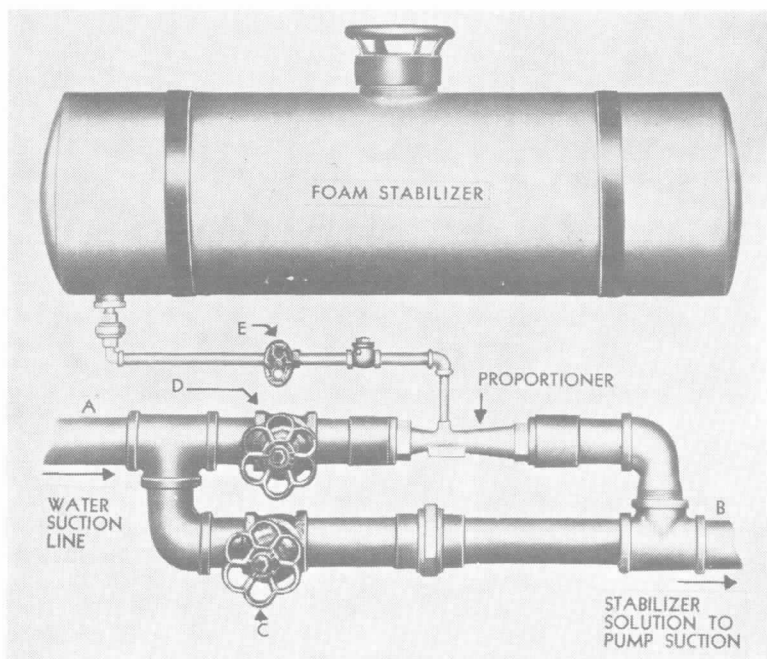
**Fig. A-1153. Air Foam Playpipe.**

**A-1154. AIR FOAM STABILIZER:** The "high expansion" type stabilizer produces about 350 gals. of air foam per gallon of stabilizer and 16 to 18 gals. of air foam per gallon of water. The "low expansion" type of stabilizer produces 120 to 200 gals. of air foam per gallon of stabilizer and 8.5 to 11.5 gals. of air foam per gallon of water. These figures are representative of playpipe performance and delivery from fixed air foam makers of the low back-pressure type. Foam production from the high back-pressure type of foam maker varies with the back-pressure imposed.

A-1155 (a) (1). **PREMIXED AIR FOAM SOLUTIONS:** The manufacturer should be consulted regarding stabilizer to be used in the preparation of premixed solution.

A-1155 (b) (1). **PUMP SUCTION METHOD:** This type of proportioner (Fig. A-1155 (b) (1)) consists of an eductor installed in the suction line to a water pump. To operate satisfactorily, the head on the water supply line must not be higher than that on the tank of air foam stabilizer.

The capacity of the proportioner may be varied from approximately 50 per cent to 200 per cent of the nominal or rated capacity as prescribed by the manufacturer.



**Fig. A-1155(b)(1). Pump Suction Proportioner.** To install: connect A to water suction line, connect B to suction side of pump. To operate foam system: close valve C, open valves D and E. To discharge plain water: close valves D and E, open valve C.

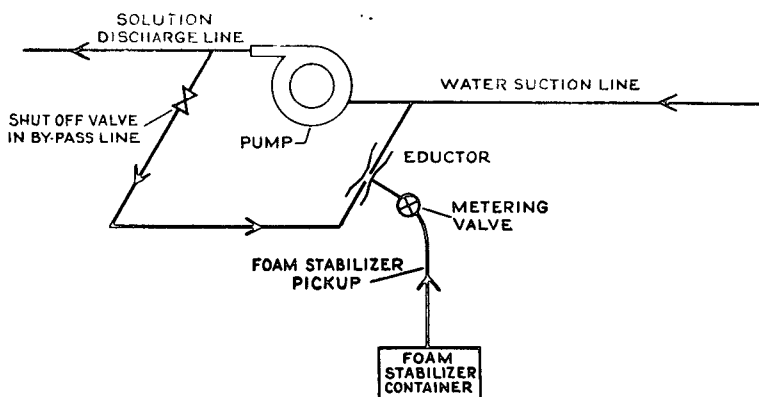


Fig. A-1155(b) (2). Around-the-Pump Proportioner.

**A-1155 (b) (2). AROUND-THE-PUMP PROPORTIONER:** This device consists of an eductor installed in a bypass line between the discharge and suction of a water pump. A small portion of the discharge of the pump flows through this eductor and draws the required quantity of air foam stabilizer from a container, delivering the mixture to the pump suction. Variable capacity may be secured by the use of a manually controlled multiported metering valve.

**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 on the pump suction can cause a reduction in the quantity of stabilizer educted and even the flow of water back through the eductor into the stabilizer container.
2. The elevation of the bottom of the stabilizer container should not be more than 6 ft. below the proportioner.
3. The bypass stream to the proportioner uses from 10 to 40 gpm of water depending on the size of the device and the pump discharge pressure. This factor must be recognized in determining the net delivery of the water pump.

A-1155 (c) (1). **PRESSURE PROPORTIONING TANK METHOD:** The arrangement of these devices may take a variety of forms. A single tank or battery of tanks manifolded together may be used. There are also single tanks divided into two separate compartments by a bulkhead and dual tank arrangements.

Where single tanks or a battery of manifolded tanks are used, it is necessary to interrupt foam production while recharging. With the compartmented tank or dual tank arrangement, continuous operation can be secured. The smaller devices are portable for use with hose streams.

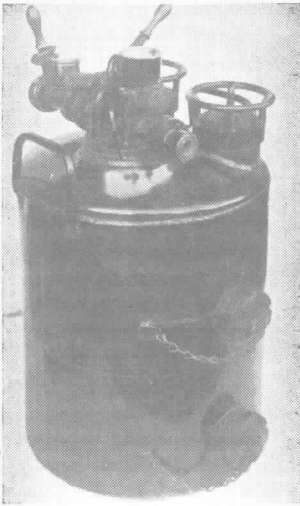
The device illustrated in A-1155 (c) (1) shows an arrangement of 2 tanks with a proportioner so installed that it can draw air foam stabilizer from either tank.

Each compartment has a screw cap on top for charging with stabilizer and a screw cap at the bottom for draining the water from the compartment upon exhaustion of the foam compound. Above each compartment is a valve which when opened permits the introduction of stabilizer from that tank into the water stream.

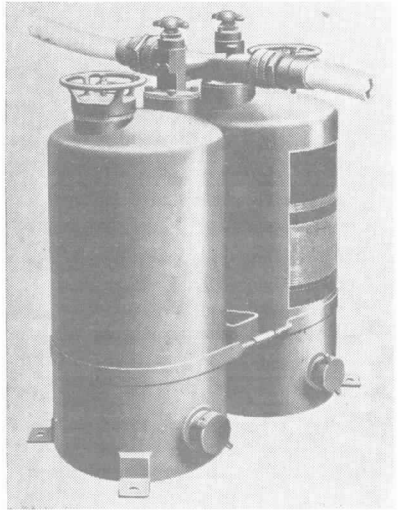
To operate, the valve on one tank is opened. When the supply of stabilizer in this compartment has been exhausted, the valve is closed and the valve on the other tank is opened. The exhausted compartment is then drained of water and refilled. This operation can be repeated continuously to provide an uninterrupted foam stream. Recharging must be done promptly and within the time required to exhaust one of the tanks. The operating range of this device is from 75 psi to 125 psi.

#### LIMITATIONS:

1. The capacity of these proportioners may be varied from approximately 50 per cent to 200 per cent of the rated capacity of the device.
2. The pressure drop across the proportioner ranges from 5 to 30 psi depending on the volume of water flowing within the capacity limits given above.
3. The length of time these devices will operate before recharging is necessary is given on the nameplate as a function of the water flowing through the eductor. This time may vary from 2 or 3 minutes for a small unit, up to 15 minutes or longer for the larger units.
4. After each use, these units must be completely emptied and recharged.



**Pressure Proportioner,  
Compartmented Single  
Tank.**



**Pressure Proportioner,  
Dual Tank.**

**Fig. A-1155(c) (1).**

**A-1155 (c) (2). IN-LINE INDUCTOR:** This inductor is for installation in a hose line, usually at some distance from the foam maker or playpipe, as a means of drafting air foam stabilizer from a container.

**LIMITATIONS:**

1. The in-line inductor must be designed for the particular foam maker or playpipe with which it is to be used. The device is very sensitive to downstream pressures and is accordingly designed for use with specified lengths of hose or pipe between it and the foam maker.
2. The pressure drop across the inductor is approximately one-third of the inlet pressure.
3. The elevation of the bottom of the stabilizer container should not be more than 6 ft. below the inductor.

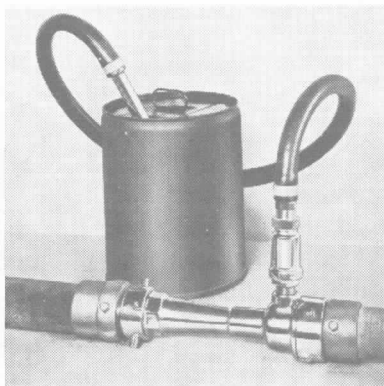


Fig. A-1155(c) (2). In-Line Inductor.

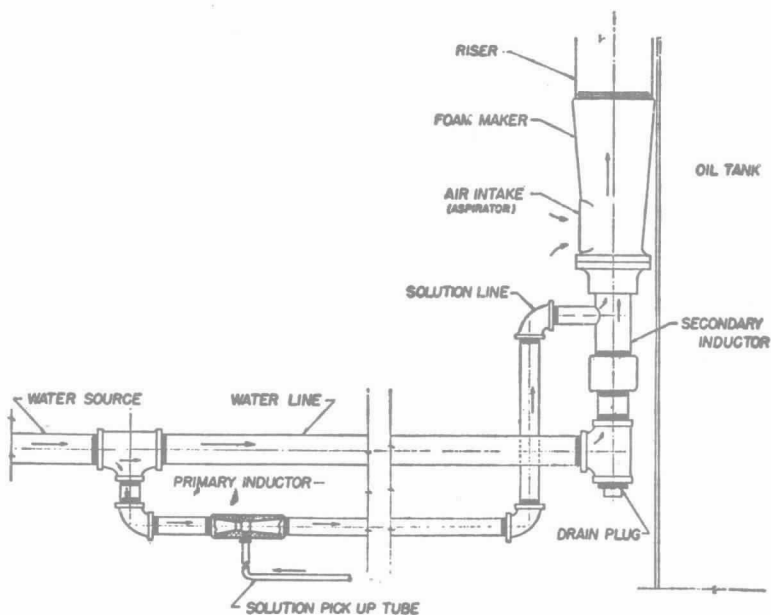


Fig. A-1155(c) (3). Air Foam Auto-induction System.  
Solution pick-up tube picks up stabilizer from its container.



A-1155 (c) (3). PRIMARY - SECONDARY INDUCTION METHOD: This method of introducing air foam stabilizer into the water stream en route to a fixed foam maker is illustrated in Fig. A-1155 (c) (3).

The unit consists of two inductors designated as the primary inductor and the secondary inductor. The primary inductor is located outside the firewall enclosure and is installed in a bypass line connected to and in parallel with the main water supply line to the foam maker. A portion of the water flows through the primary inductor and draws the stabilizer from a container by means of a pick-up tube.

The main water line discharges through the jet of a secondary inductor located at the foam maker proper, the mixture of water and stabilizer from the primary inductor being delivered to the suction side of the secondary inductor.

#### LIMITATIONS:

1. The primary inductor may be installed as much as 500 ft. from the secondary inductor. The size of piping used, both in the water and the solution lines, should be as specified by the manufacturer.
2. The elevation of the bottom of the stabilizer container should not be more than 6 ft. below the primary inductor.

A-1155 (c) (4). PRESSURE SIDE PROPORTIONER: 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 playpipe. The inductor may be inserted in the line at any point between the water source and foam maker or playpipe.

To operate, the main water valve is opened and a reading of the pressure indicated on the duplex gage is taken. The bypass valve in the line between the suction and discharge of the foam stabilizer pump should be opened fully and the pump started. By slowly closing the bypass valve to increase the discharge pressure of the foam stabilizer, the second pointer on the duplex gage is brought to coincide with the indicated water pressure. When both gage hands are set at the same point, the proper amount of foam stabilizer is being injected into the water stream.

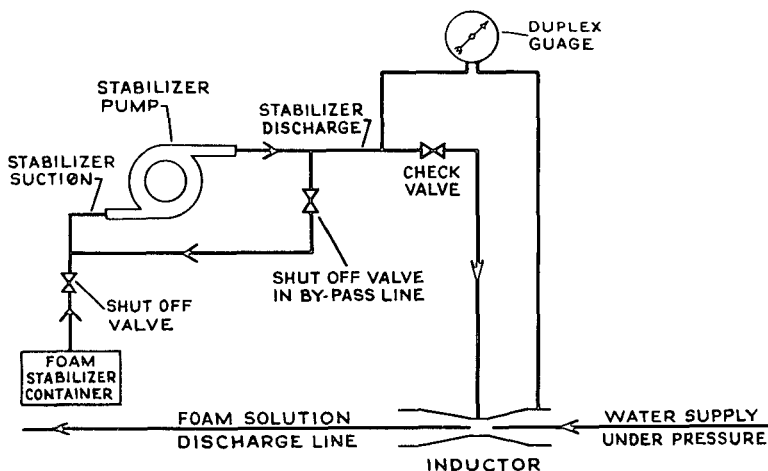


Fig. A-1155(c) (4). Pressure Side Proportioner.

#### LIMITATIONS:

1. The capacity of the proportioner may be varied from approximately 50 per cent to 200 per cent of the rated capacity of the device.
2. The pressure drop across the proportioner ranges from 5 to 30 psi depending on the volume of water flowing through the inductor within the capacity limits given above.
3. A separate pump is required to deliver stabilizer to the inductor.

A-1155 (c) (5). **WATER MOTOR PROPORTIONER:** This device consists of two positive displacement rotary pumps mounted on a common shaft. Water delivered to the larger pump causes it to drive the smaller pump which is used to draft stabilizer from a container and deliver it to the water discharge line from the larger pump. By proportioning the sizes of the two pumps, the correct volume of stabilizer is delivered to the water stream.

**LIMITATIONS:** The pressure drop across this proportioner is 25 per cent at 100 psi at maximum flow. The volume of water flow governs the volume of stabilizer delivered into the water stream. It is manufactured in only two sizes. The smaller will proportion within acceptable

limits between 60 and 180 gpm. The larger will proportion between 200 and 1000 gpm with stabilizer concentrations between  $6\frac{1}{2}$  and  $5\frac{1}{2}$  per cent. It has no limitations in respect to pressure.

A-1155 (d) (1). BUILT-IN INDUCTOR IN FOAM MAKER: Figures A-1151 and A-1153, show this type of proportioner where one or more of the jets in the foam maker are utilized to draft the stabilizer.

LIMITATIONS: The bottom of the stabilizer container should not be more than 6 ft. below the level of the foam maker. The length and size of hose or pipe between the stabilizer container and the foam maker should conform to the recommendations of the manufacturer.

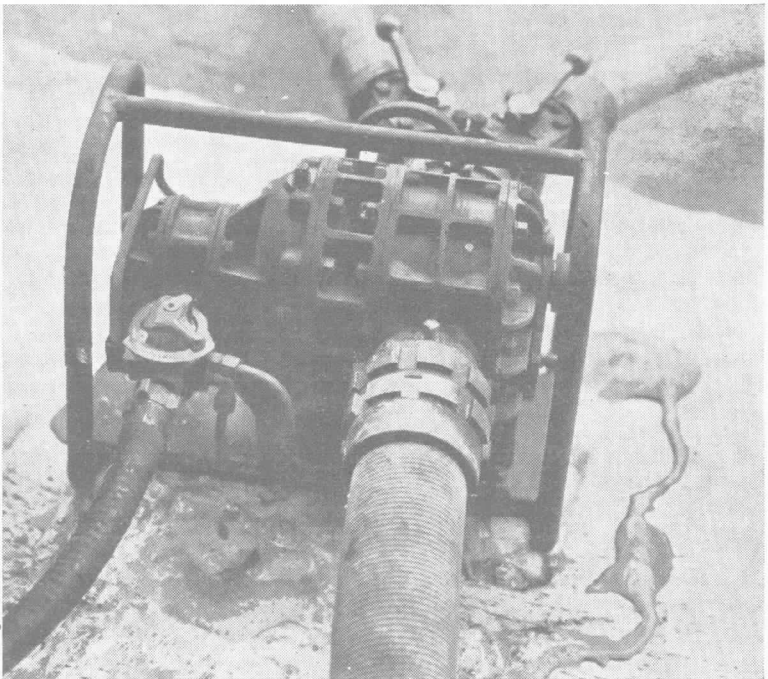


Fig. A-1155(c) (5). Water Motor Proportioner.

A-1213. **USE OF FOAM TO PREVENT FIRE:** For example, a tank truck or tank car wreck should be covered by foam before ignition takes place. Spills in garages, airplane hangars, etc., may be effectively handled in the same manner.

A-122. **LIMITATIONS:** Foam is not considered a suitable extinguishing agent for fires involving liquefied compressed gases, e.g., butane, butadiene, propane, etc.

Judgment must be used in applying foam to vessels containing hot oils, asphalts, etc., which are above the boiling point of water either normally or due to an exposure fire and to vessels containing high viscosity oils, such as Bunker C fuel oil, which have been burning for extended periods. The water in the foam may cause violent frothing of the contents and even the forceful expulsion of a portion of the contents.

Foam hose streams are not recommended for use on fires involving electrical equipment where the foam could come in contact with energized equipment.

Foam is not suitable for use on materials which will react violently with water (e.g., metallic sodium) or which produce hazardous materials by reacting with water.

Certain wetting agents are incompatible with some foams. Dry chemical powder extinguishing agents may in general exhibit the same reaction.

The possibility and extent of agent damage 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 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.

A-132. **FOAM MIXING CHAMBERS FOR CHEMICAL FOAM:** The minimum volume of a mixing chamber (in gallons) should be approximately one-thirtieth of the water rate to the chamber in gallons per minute.

A-134. **WATER SUPPLIES:**

**QUALITY:** Ordinary water supplies, whether fresh or salt, hard or soft, have no significant effect on the quality or volume of foam produced. There may be unusual circumstances where the water will contain minerals, silt,

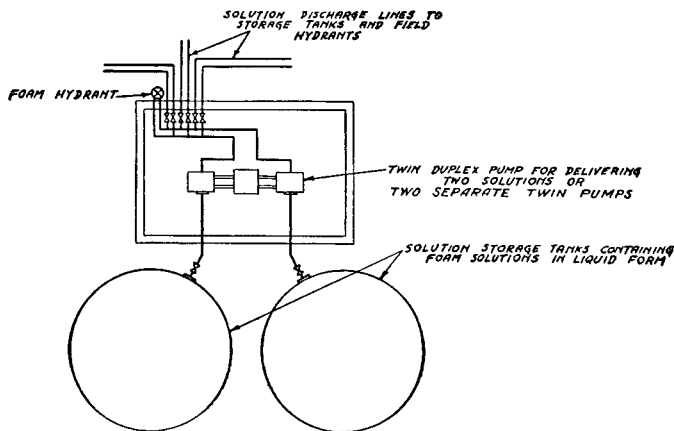
organic matter or trade wastes which will affect foam quality. Possible variation in quality of process cooling water which is also to be used for foam systems should be considered. The manufacturer and the authority having jurisdiction should be consulted.

**TEMPERATURE:** Foam chemicals work best when water temperatures are not less than 50°F. nor more than 100°F. Optimum results are obtained at temperatures from 60° to 70°F. Low water temperatures retard the chemical reaction so that longer mixing time must be provided. High water temperatures produce foam which is more susceptible to breakdown.

Air foam production is much less sensitive to variations in water temperature than chemical foam production, but is best when water temperatures are between 40° and 100°F.

**A-1344. STRAINERS:** Where the water is clear, a simple strainer should be provided. Where the water is moderately contaminated, self-cleaning strainers accessible for cleaning during the emergency should be used. Dual type strainers, or the equivalent, may be necessary if water supplies are badly contaminated. Strainers may be installed in the water supply line or as part of the foam apparatus. Strainers may also be required near foam makers served by long pipe lines where scale may exist.

#### A-144. WET STORAGE CHEMICAL FOAM SYSTEMS:



**Fig. A-144.** Typical two solution (acid and basic) chemical foam system layout. Discharge line layout similar to that for two powder type shown in A-1452B.

A-1442. Experience shows that foam solutions now in use work best at temperatures not less than 50° nor above 100°F. Storage at high temperatures favors decomposition of the sodium bicarbonate solution.

A-1445. This usually requires a twin duplex pump or two identical pumps operated from a common prime mover.

#### A-1452. CENTRALIZED FIXED PIPING SYSTEMS:

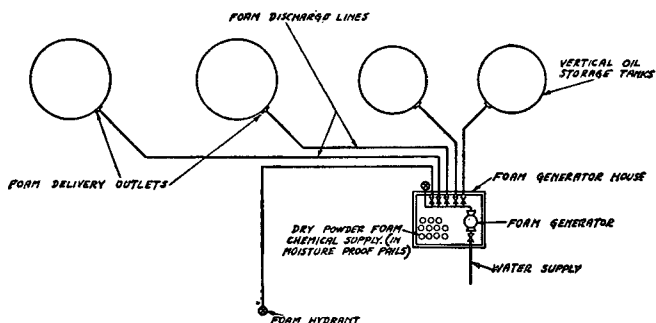


Fig. A-1452A. Typical chemical foam generator system layout of the single powder type.

Diagram not to scale. Foam generator houses should be located well away from tanks. Dikes not shown.

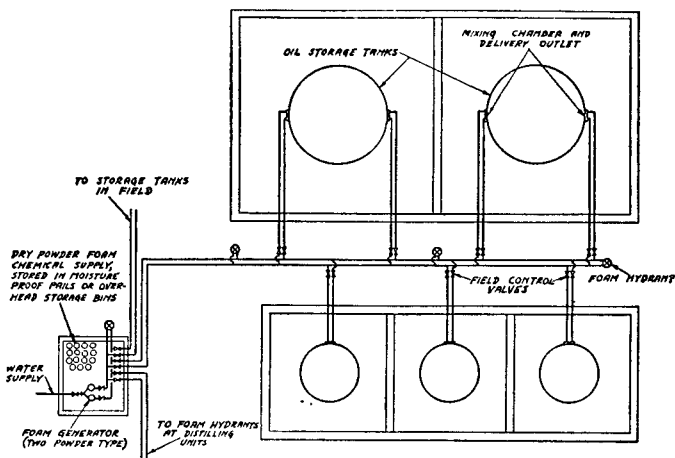
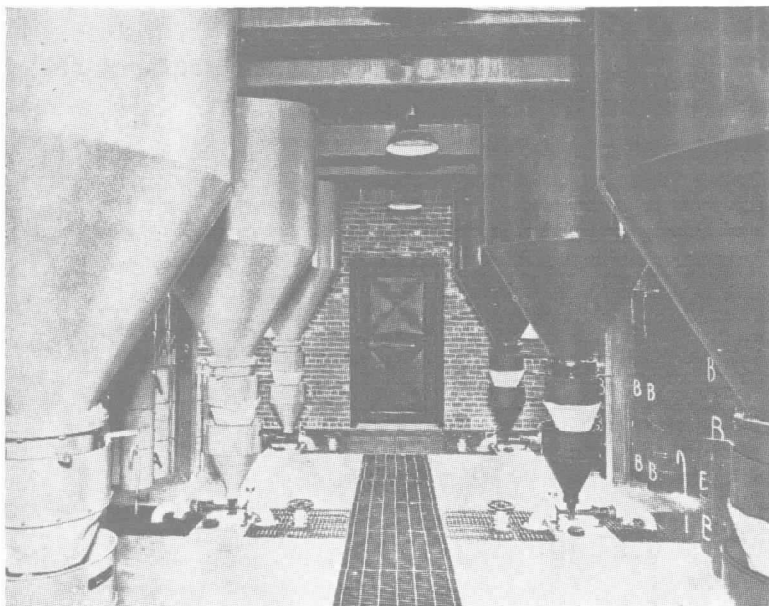


Fig. A-1452B. Typical chemical foam generator system layout of the two powder type.

**A-1452 (a). DUAL POWDER GENERATOR SYSTEM WITH POWDER IN BINS:**

A-1452 (b). The facilities must be laid out so as to provide ample working space in which to handle portable containers of powder, to open the containers, to deliver the powder to the generators, and to dispose of the empty containers without interrupting the flow of chemicals to the generators. Pails of powder should be piled not over five high. If the system is a dual powder system, the pails should be arranged so that both "A" and "B" powder pails can be handled without confusion. Clear access to the generator house should be provided so that additional supplies can be brought in if needed.



**Fig. A-1452(a). Dual Powder Generator System with Powder in Bins.**

**A-146. AIR FOAM SYSTEMS:**

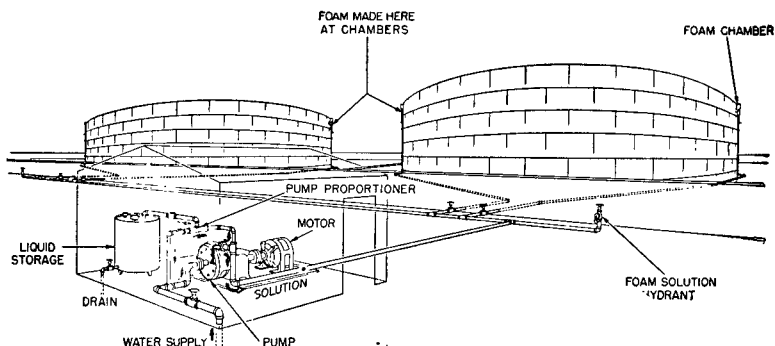
**A-200. GENERAL:** This section includes such hazards as the storage of oils or other flammable liquids, as well as occupancies where flammable liquids are used or processed. This class of protection may be used for such hazards as dip tanks or dipping processes, quench tanks, impregnating tanks, mixing tanks, etc. (See Figs. A-1141 and A-1151.) It may also be used to protect oil pump rooms, benzol storage rooms, certain paint storage rooms, warehouses storing petroleum products and other flammable liquids, etc.

Water applied to fires in such occupancies may spread burning liquids about the room to other areas, and containers of flammable liquids may be upset by solid hose streams.

Figures A-200 A and A-200 B show overhead air foam spray devices. They are usually installed at or near the ceiling of a building and are spaced so as to provide complete foam coverage of the floor area as well as the contents of the room.

**A-2211.** It is the intent of this paragraph that a foam blanket at least 4 in. thick be produced.

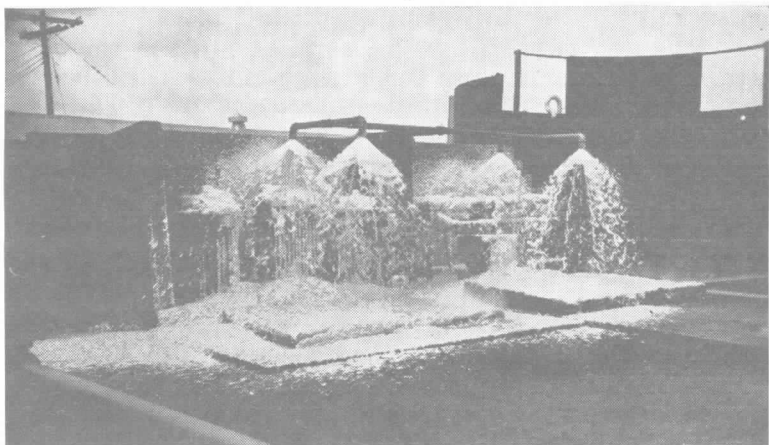
**A-2221.** It is the intent of this paragraph that a foam blanket at least 6 in. thick be produced.



**Fig. A-146. Schematic arrangement of air foam protection for storage tanks.**

Liquid storage indicated lower left of illustration is stabilizer storage.





**Fig. A-200A. Overhead Air Foam Spray.**



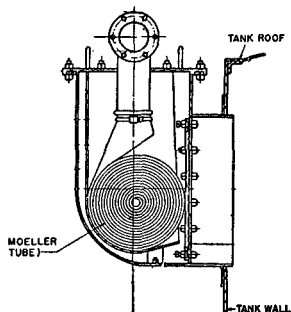
**Fig. A-200B. Overhead Air Foam Spray.**

A-251. **AUTOMATIC CONTROLS:** The uncontrolled discharge of water may displace the foam blanket deposited unless suitable overflow drains are provided.

A-300. **GENERAL:** These systems are for the protection of outdoor process and storage tanks. They include the protection of such hazards in manufacturing plants as well as large oil farms, oil refineries and chemical plants. The systems are usually designed for manual operation but, in whole or in part, may be automatic in operation. Foam systems are the preferred protection for large outdoor tanks of flammable liquids.

A-3012. **TYPE I DISCHARGE OUTLETS:** Among the approved Type I discharge outlets are:

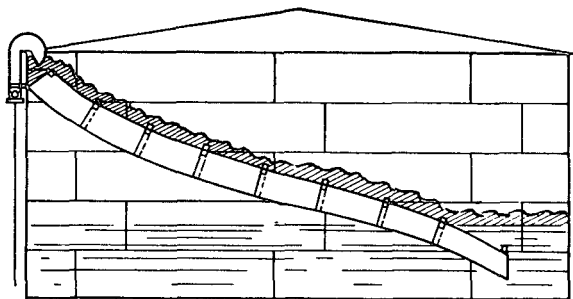
- (a) Porous asbestos tube (see Fig. A-3012 A).
- (b) Foam trough along the inside of tank wall (see Fig. A-3012 B).



**Fig. A-3012A. Cross-section Moeller Tube Chamber.**

Tube is designed to unroll and fall to oil level.

Foam flows through interstices in tube.



**Fig. A-3012B. Foam Trough.**

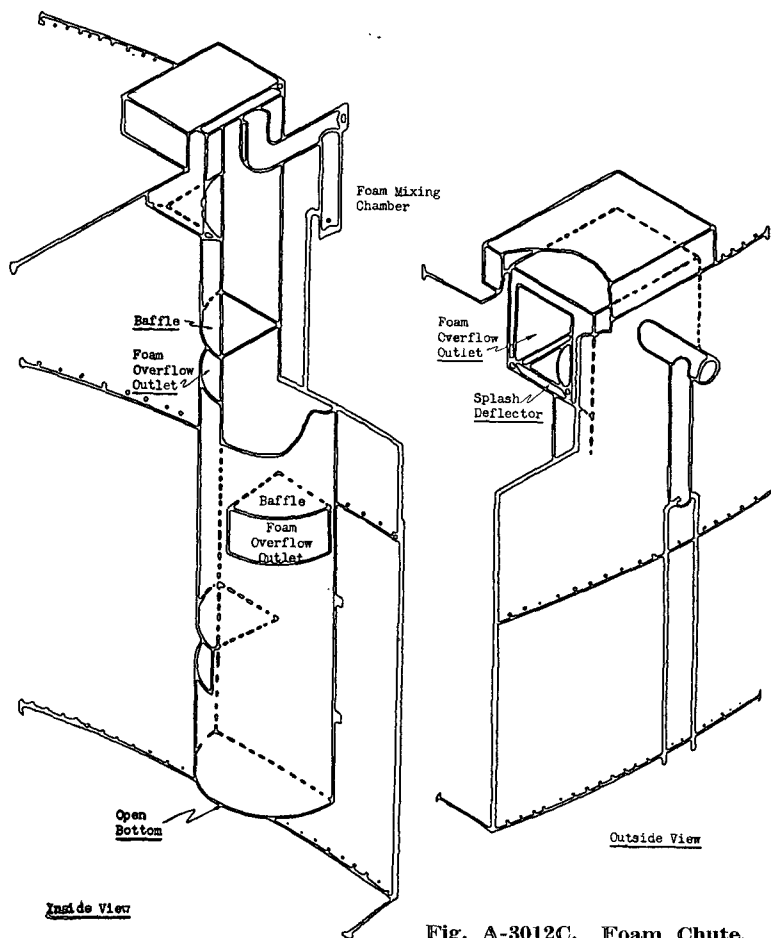


Fig. A-3012C. Foam Chute.

(c) Foam chute or ladder (see Fig. A-3012 C).

These are designed to extinguish fire with a minimum of foam-producing materials. It should be noted, however, that Type I devices become Type II devices if they suffer mechanical damage.

**POROUS ASBESTOS TUBE:** The coarsely woven asbestos tube is rolled up in the foam chamber, one end being

securely fastened to the foam supply line, the free end being stitched so as to close the opening at this point. When foam is admitted to the tube, the diaphragm closing the mouth of the chamber is broken out by the pressure of the tube against it. The tube then unrolls, dropping into the tank. The buoyancy of the foam causes the tube to rise to the surface and foam flows forth through the interstices of the fabric directly onto the liquid surface.

**FOAM TROUGH:** The trough shown schematically in Fig. A-3012 B consists of sections of steel sheet formed into a chute which is securely attached to the inside of the tank wall so that it forms a descending spiral from the top of the tank to within 4 ft. of the bottom.

**FOAM CHUTE:** The device illustrated in Fig. A-3012 C consists of a foam mixing chamber (external to the tank) and an internal delivery conduit or chute. Staggered openings are provided at intervals in the conduit. The foam delivered piles up in the chute and emerges through the first opening immediately above the liquid surface. The discharge of foam through the higher openings is prevented by the use of baffles which shield the openings. The maximum distance that the foam must drop onto the liquid surface is regulated by the spacing of the overflow outlets.

#### A-3013. TYPE II DISCHARGE OUTLETS.

See illustrations A-3013 A and A-3013 B.

Where type II outlets are used with alcohol type hazards, the manufacturer should be consulted for adequacy of protection.

A-3014. Fixed systems are preferred because there is a minimum of manpower required for their operation, and they can be put into action more quickly than portable means.

A-3015. **SEMI-PORTABLE INSTALLATIONS:** These systems are less reliable than fixed systems, particularly where large tanks are involved. A relatively large crew, well trained in the use of the apparatus, is needed. Adequate facilities to transport the equipment and a good road system throughout the property are necessary.

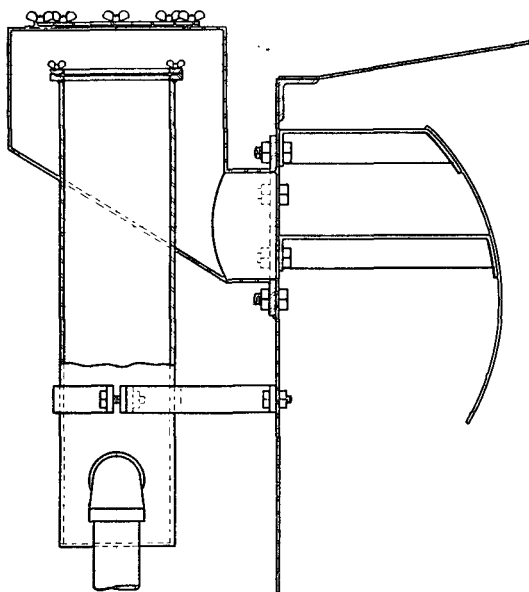


Fig. A-3013A. Chemical Foam Chamber.

A-311 — A-312. GENERAL: These requirements of 1 gpm of water (or solutions) per 10 sq. ft. of liquid surface are equivalent to the requirements of former editions of this standard which were expressed in terms of foam volumes. In the case of the liquid hydrocarbons, for example, a delivery rate of  $\frac{3}{4}$  gal. of foam per sq. ft. of burning area was specified as minimum. This foam was produced either by (1) the reaction of one gallon of combined A and B ( $\frac{1}{2}$  gal. of each) wet solutions or (2) the reaction of 1 lb. of combined A and B powders with 1 gal. of water. Either of these types of foam production resulted in 7.5 gals. (or 1 cu. ft.) of foam.

Obviously, if one-tenth of this volume of foam — or  $\frac{3}{4}$  gal. — was specified for the protection of each sq. ft. of burning surface, then one-tenth of its water volume is used, or .1 gpm for the application. This water rate is equivalent to 1 gpm per 10 sq. ft. used throughout this standard.

A-312. RATE OF APPLICATION: Water Soluble Solvents. The system shall be designed on the basis of fighting

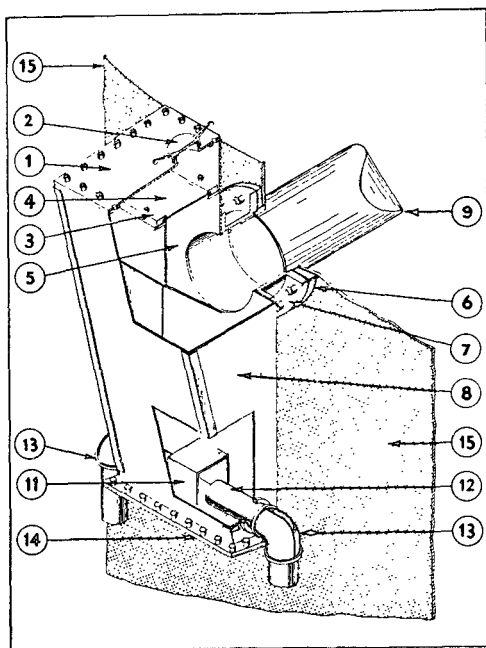


Fig. A-3013B. Chemical foam chamber. (1) Top plate. (2) Inspection cap. (3) Diaphragm frame. (4) Diaphragm. (5) Inner chamber. (6) Adapter flange shaped to fit tank curvature. (7) Chamber throat and mounting flange. (8) Chamber body. (9) Deflector. (11) Baffle. (12) Inlet nipples. (13) Inlet solution elbows. (14) Bottom plate. (15) Tank shell.

a fire in but one tank at a time. The rate of application for which the system is designed shall be the rate computed for the protected tank considering both the liquid surface area and the type of flammable liquid stored.

Example: The property contains 40 ft. diameter tanks storing ethyl alcohol and 30 ft. diameter tanks storing diethyl ether.

Liquid surface area, 40 ft. diameter tank	= 1257 sq. ft.
Rate of water application for ethyl alcohol, 1 gpm/ 10 sq. ft. or $125.7 \times 1.0$	= 126 gpm
Liquid surface area, 30 ft. diameter tank	= 707 sq. ft.
Rate of water application for diethyl ether, 2.7 gpm/ 10 sq. ft. or $70.7 \times 2.7$	= 190 gpm

In this case the smaller tanks storing the more volatile product require the higher foam generator capacity. In applying this requirement due consideration must 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 may contain quantities of impurities or diluents. The proper