NFPA No. 11

Standards

for

FOAM EXTINGUISHING SYSTEMS

1951

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No. 11 1951

STANDARDS FOR FOAM EXTINGUISHING SYSTEMS.

This edition of the Standard on Foam Extinguishing Systems incorporates amendments adopted by the National Fire Protection Association on May 11, 1951 on recommendation of the Committee on Foam Extinguishing Systems and with the concurrence of the General Committee on Special Extinguishing Methods. The present edition supersedes the edition of 1950 as printed by the NFPA in Standard No. 11 and also by the National Board of Fire Underwriters in NBFU Pamphlet No. 11. It also supersedes the text of this standard printed in the National Fire Codes, Vol. IV, Extinguishing and Alarm Equipment, edition of 1951. The present text is the latest in a series of editions dating back to 1921. The history of prior editions will be found in the National Fire Codes and more detailed records of NFPA action in the Proceedings from 1921 to date.

Contents.

Definitions.

The terms in these standards are used in accordance with their commonly accepted meanings.

In accordance with an official ruling by the NFPA Board of Directors, the terms "shall," "should," and "approved" are defined as follows:

SHALL is intended to indicate requirements.

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

APPROVED refers to approval by the authority having jurisdiction.

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. These standards also cover 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.

SECTION I.

GENERAL REQUIREMENTS AND INFORMATION.

*11-00. Introduction.

11-10. PURPOSE: These standards cover the minimum requirements for the installation and use of foam systems and portable apparatus for fire protection and extinguishment and are 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.

11-20. SCOPE: These standards cover 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.

11-30. 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.

11-40. 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.

*11-41. 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.

*11-42. 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.

*See Appendix, corresponding numbered paragraphs.

11-43. 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.

*11-44. 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.

11-45. FOAM POWDER: Chemical foam powder comes in three types:

*11-45.10. 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.

*11-45.20. 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 §11-45.10.

*11-45.30. 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 §11-41, §11-45.10, §11-45.20 and §11-50. It is also suitable for use on fires in liquid hydrocarbons.

†NOTE: The term "Water Soluble Solvents" refers to those liquids which contain oxygen and 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.

*11-50. 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.

*11-51. 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.

*11-52. 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.

*11-53. 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.

*11-54. AIR FOAM STABILIZER: Air foam stabilizer is a liquid which, depending on its concentration and nature, is used in a proportion from 3% to 6% in water as recommended by the manufacturer and as approved by inspection authorities having jurisdiction. There are two fundamental types of air foam stabilizer: "low expansion," and "high expansion."

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

11-55. 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:

11-55.10. PREMIX METHOD.

*11-55.11. By premixing a suitable air foam stabilizer directly into the water in a booster or other storage tank.

11-55.20. PROPORTIONER AT THE MAIN PUMP.

*11-55.21. 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.

*11-55.22. Around-the-Pump-Proportioner—By means of a venturi inducting proportioner located in a bypass between the pump discharge and the pump suction.

11-55.30. PROPORTIONER BETWEEN THE MAIN PUMP AND THE FOAM MAKER.

*11-55.31. 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.

*11-55.32. In-Line Inductor—By inducting the stabilizer through approved single or multiple inductors located in the water line to the foam maker.

*11-55.33. 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.

*11-55.34. Pressure Side Proportioner—By forcing stabilizer into the flowing water stream through an approved pressure side proportioner by means of a stabilizer pump.

*11-55.35. Water Motor Proportioner—By means of a displacement type stabilizer pump operated by a displacement water motor.

11-55.40. PROPORTIONER AT THE FOAM MAKER.

*11-55.41. 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.

12-00. Uses and Method of Application.

12-10. 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.).

12-11. 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.

12-12. Exposure protection of an exceptionally high order is provided by the application of foam blankets. The heat resistance of foam as defined in these standards is very high and heat transmittal is exceptionally low.

*12-13. Prevention of fire may also be provided by applying foam blankets to spills or other hazardous areas to prevent ignition.

*12-20. LIMITATIONS: Foam has certain limitations of use which must be recognized (see Appendix).

13-00. System Requirements.

13-10. 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 §11.30.

*13-20. 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.

13-30. DISCHARGE OUTLETS.

13-30.10. 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.

13-30.20. Discharge outlets may be in combination with mixing devices or may be separate devices.

*13-40. WATER SUPPLIES: All foam systems except stored solution systems depend for their operation upon a source of water at suitable pressure.

13-41. QUANTITY: The water supply must 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.

13-42. 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 §13-41).

*13-43. STRAINERS: Strainers capable of removing from the water all solids of sufficient size to obstruct openings in the foam apparatus shall be provided.

13-44. DESIGN: The water system shall be designed and installed in accordance with principles recognized in standards for such extinguishing systems (see Appendix A-11-00).

13-44.10. 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 inspection department having jurisdiction.

14-00. Storage of Foam-Producing Materials.

14-10. 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, non-combustible structure situated in an accessible location not seriously exposed by the hazard it protects. Where acceptable to the inspection department 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.

14-20. LOCATION, PORTABLE MATERIALS: Where the materials are entirely portable, and distributed about the premises, the inspection department having jurisdiction should be consulted as to location and housing. (See also §14.50 and §14.60 for additional requirements for the storage of various foam-producing materials.)

14-30. OFF-PREMISES STORAGE: The inspection department 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% 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.

*14-40. WET STORAGE CHEMICAL FOAM SYSTEMS.

14-41. Where two-solution storage is used, the solutions should be stored and contained in tanks conforming to the NFPA Standards for the Construction and Installation of Gravity and Pressure Tanks, 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.

*14-42. Suitable provision shall be made when necessary for maintaining the supply of foam-producing solutions at temperatures that will not inhibit normal chemical action.

14-43. Means should be provided for the agitation or circulation of the liquids to assure uniform solutions.

14-44. Facilities separate from the storage tanks shall be provided for dissolving and preparing the chemicals to permit of prompt restoration of the system to operating condition after use.

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

*14-45. 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.

14-46. Suitable means shall be provided for making full pump capacity tests with water.

14-50. DRY STORAGE CHEMICAL FOAM SYSTEMS.

14-51. Dry foam-producing chemicals shall be stored in approved containers in a location not subject to abnormal deterioration, subject to the approval of the inspection department having jurisdiction.

*14-52. CENTRALIZED FIXED PIPING SYSTEMS.

*14-52.10. STORAGE IN CONTAINERS OF LARGE CAPACITY: Where systems require more than 10,000 pounds of foam-producing chemicals, it is recommended that at least 50% 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 power 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.

*14-52.20. 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.

*14-60. AIR FOAM SYSTEMS.

14-61. 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 must not be stored where the temperature is below 32°F. or above 120°F. It shall be stored in a location free of excessive moisture to avoid external corrosion of containers and other equipment.

15-00. Piping Installation Requirements.

15-10. MATERIALS.

15-11. PIPING: Piping shall be steel, suitable for the pressure involved, but not less than standard weight, in accordance with current American Standards.

15-12. 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.

15-13. 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.

15-20. 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.

15-30. INSTALLATION: Installation shall conform to the applicable NFPA Standards as modified herein (see Appendix A-11-00).

15-40. FLUSHING: All system piping shall be flushed where practicable, otherwise cleanliness shall be determined by visual examination. Provision shall be made in the design to permit flushing with clean fresh water after use.

15-50. TEST GAUGE: A test gauge connection shall be provided on each side of each chemical foam generator, air foam proportioner, and system pump and at each lateral control valve.

16-00. Plans and Specifications.

16-10. REQUIREMENTS: Foam system layout and installation should be entrusted to none but fully experienced and responsible persons. Before fixed foam systems or portable equipment is installed or existing equipment remodeled, complete working plans and specifications should be submitted

for approval to the inspection department having jurisdiction. Any material deviation from the approved standards, will require special permission from the inspection department. 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 inspection department 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.

16-11. Hydraulic characteristics of foam proportioners and of foam makers as determined by tests shall be supplied by the manufacturer to the user and inspection department (including the range of operating conditions required for the proposed installation), to permit determination of the adequacy of the hydraulics of the proposed protection.

16-20. TEST RESULTS TO BE SUPPLIED: For the following equipment, equipment manufacturers shall supply test results to the owner and to the inspection department having jurisdiction:

16-21. SINGLE LINE CHEMICAL FOAM GENERATORS.

(a) Water rate at 100 p.s.i. inlet water pressure.

(b) When operating at 100 p.s.i. 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 §34-22, and also when delivering to the foam pipe and hose stream layout (with nozzle size stated) given in the table under §34-22.

(c) If the pipe line layout differs from that specified in §34-22, either by the use of longer pipe lines or by the use of pipe sizes other than those specified in §34-22, or if the water rating of the generator at 100 p.s.i. inlet water pressure exceeds that specified, then test data for the proposed layout shall be obtained and submitted.

16-22. CHEMICAL FOAM SOLUTION GENERATORS.

(a) Water rate at 100 p.s.i. inlet water pressure.

(b) When operating at 100 p.s.i. 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 p.s.i. (40% of the inlet water pressure).

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

16-23. AIR FOAM.

16-23.10. SOLUTION PROPORTIONERS.—When operating at water pressures of 50 and 100 p.s.i. on the supply side of the proportioner, the following data:

(a) Water rate.

(b) Solution rate.

(c) Pressure on each side of the proportioner.

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

16-23.20. FOAM MAKERS.

(a) Water rates and foam production of the foam makers at 50 and 100 p.s.i. at the foam makers.

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

17-00. Approvals.

17-10. All plans and specifications pertinent to the installation shall be approved by the inspection department having jurisdiction prior to installation. The inspection department 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 inspection department 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.

18-00. Acceptance Tests.

18-10. PRESSURE TESTS: All piping shall be subjected to a two-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 National Fire Protection Association Standards for Sprinkler Equipments. All normally dry horizontal piping shall be checked to determine if proper drainage pitch is provided.

18-20. OPERATING TESTS: Before acceptance, fixed foam systems shall be subjected to such tests as may be required by the inspection department having jurisdiction. Wherever practicable these tests shall include operation of all devices and equipment installed as part of the system.

*18-30. DISCHARGE TESTS: Approval and acceptance of foam systems should 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.

19-00. Maintenance.

19-10. 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 (see Appendix, A-11-00).

19-20. 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.

19-30. 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.

19-40. 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 inspection department having jurisdiction.

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

19-41. Manual tripping devices and valves, including O. S. & Y. gate and post indicator valves, shall be operated at least twice a year.

19-50. SYSTEM RESTORATION AFTER USE.

19-51. 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.

19-52. After each operation, devices mixing foam chemicals and making foam shall be cleaned and inspected.

*19-60. INSPECTION OF FOAM-PRODUCING MATERIALS.

19-61. Periodic inspection should be made of stored chemicals, powder, air foam stabilizer, etc., and their containers.

19-70. 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.

SECTION II.

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

*20-10. GENERAL: This section 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 Section may also be applied to small outside tanks having a liquid surface not exceeding 200 square feet.

21-00. Rate of Application.

21-10. RATE OF APPLICATION: The rate of discharge to foam outlets protecting the hazard or area shall be at least as follows:

21-11. 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.

21-12. 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.

21-13. 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 square feet of liquid surface area of the tanks to be protected.

21-14. The rate of discharge and supply of foam-producing materials as required by §§21-12, 22-11 and 22-21 shall be provided for hazards involving water soluble solvents. Protection of these hazards requires the use of "alcohol" type foam (see §11-45.30).

22-00. Supply of Foam-Producing Materials.

22-10. FOAM SYSTEMS FOR LOCALIZED INSIDE HAZARDS AND FOR SMALL OUTSIDE TANKS.

*22-11. There shall be provided a quantity of foam-producing materials sufficient to operate the equipment at the discharge rate specified in §21-10 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 inspection department having jurisdiction shall be consulted in each case as to the minimum quantity of foam producing materials required.

22-12. If the tank contents are not maintained at a constant level (not lower than 5 feet below the rim) apply the rules for outdoor storage tanks, Section III, and provide materials for applying foam for 20 minutes.

22-13. 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.

22-20. FOAM SYSTEMS FOR ROOMS AND BUILDINGS.

*22-21. There shall be provided a quantity of foam-producing materials sufficient to operate the equipment at the discharge rate specified in §21-10 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 inspection department having jurisdiction shall be consulted in each case as to the minimum quantity of foam-producing materials required.

22-22. 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.

23-00. System Piping.

23-10. Piping shall be so arranged as to reduce friction to a reasonable minimum.

23-11. 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.

23-12. Foam distribution piping shall be arranged to drain and should have a pitch toward drain ½ in. in ten feet.

23-13. 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.

23-14. INSTALLATION: The installation standards for foam system piping shall be the applicable sections of the NFPA Standards for Sprinkler Equipments except as herein modified. Welding in accordance with A.S.A. 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.

23-20. 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.

24-00. Discharge Outlets.

24-10. 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.

24-20. 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.

24-30. 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.

24-40. 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.

25-00. Operation and Control of Automatic Foam Systems.

*25-10. 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 inspection department 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 inches, or 4 inches in case of tanks over 25 square feet in area. (See NFPA Standards for Dip Tanks.)

25-20. 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.

25-30. 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 fifty pounds.

25-40. It is recommended that other fire protection devices have releases independent of the foam releases.

25-50. 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.

25-51. 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 for supervisory service; see standards of National Fire Protection Association for:

Carbon Dioxide Fire Extinguishing Systems (No. 12)

Sprinkler Equipments (No. 13)

Water Spray Systems (No. 15)

Central Station Protective Signaling Systems (No. 71)

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

26-00. Manually Operated Systems.

26-10. 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 non-working 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 inspection department having jurisdiction.

26-20. 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.

27-00. Alarms.

27-10. Automatic alarms shall be provided if required by the inspection department having jurisdiction, these to operate simultaneously with the release devices or with the automatic action of the means of supply.

28-00. Foam Equipment—Hand Operated.

28-10. First aid extinguishers shall be provided as required by the NFPA standards for First Aid Extinguishers. For large or severe risks, foam hose lines should be provided in accordance with Section V hereof.

SECTION III.

PROTECTION OF OUTDOOR STORAGE TANKS BY FIXED FOAM DISCHARGE OUTLETS.

*30-10. GENERAL: This section contains requirements, in addition to those given in Section 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.

30-20. DEFINITIONS.

30-21. 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 Section IV.

*30-22. 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.

*30-23. 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.

*30-24. FIXED INSTALLATIONS: These are complete installations piped from a central foam house to the tanks, discharging through fixed delivery outlets on the tanks.

*30-25. SEMI-PORTABLE INSTALLATIONS.

30-25.10. The type in which tanks are equipped with fixed discharge outlets and piping which terminates at a safe distance from the tanks. The foam apparatus, foam-producing materials, hose, etc., are transported to the scene after the fire starts and connected to the piping.

30-25.20. 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 Section IV); or applied by hose streams (see Section V).

31-00. Rate of Application.

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

*31-10. TO TANKS CONTAINING LIQUID HYDROCARBONS.

31-11. 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.

31-12. For dry powder foam generator systems the water rate to the generators shall be at least one gpm for each ten square feet of liquid surface area of the tank to be protected.

31-13. For air foam systems the delivery rate to the foam makers shall be at least one gpm of water (including stabilizer) for each ten square feet of liquid surface area of the tank to be protected.

31-14. For highly volatile materials such as casinghead gasoline (25 to 40 lbs. Reid vapor pressure), higher rates of application are required, possibly as high as double the rates specified in §31-11, §31-12 and §31-13.

*31-20. 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, etc.	1.3
Products such as diethyl ether, etc.	2.7

31-21. Protection of these water soluble solvents requires the use of alcohol type foam (see paragraph 11-45.30).

32-00. Supply of Foam-Producing Materials.

*32-10. 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.

32-11. The minimum total supplies to be maintained shall be the sum of the quantities defined in §§32-20, 32-32 and 32-40.

32-20. 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 §31-00 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 §§30-22 and 30-23 for definitions.

WATER SOLUBLE SOLVENTS		
Products such as methyl, ethyl and isopropyl alcohols, ethyl acetate, etc.	20 min.	30 min.
Products such as isopropyl ether, etc.	20 min.	30 min.
Products such as diethyl ether, etc.	25 min.	50 min.

NOTE: If the apparatus available has a delivery rate higher than that specified in §31-00 proportionate reduction in the time figures given may be made. Tanks containing flammable liquids having a flash point over 200°F. closed cup are not, as a rule, required to be protected by foam.

32-21. DRY POWDER GENERATORS: For the purpose of Section 32-00 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.

32-30. FOAM HOSE STREAMS.

*32.31. Approved foam hose stream equipment shall be provided as supplementary protection for ground fires. The minimum number of hose streams required shall be as specified in §32-32. 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.

32-32. Additional foam-producing materials shall be provided to permit operation of the hose stream equipment specified for the period set forth below:

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

*Based on simultaneous operation of the minimum number of hose streams required and of the size specified in §32-31. Adjustment may be made where streams of greater capacity are provided.

32-40. 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.

33-00. Foam Discharge Outlets.

33-10. 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 §31-00.

*33-11. Tanks up to 65 feet in diameter shall have at least one approved discharge outlet; tanks over 65 feet to 117'6" diameter shall have at least two discharge outlets; tanks over 117'6" to 140 feet in diameter shall have at least three discharge outlets; tanks over 140 feet in diameter shall have at least four discharge outlets.

33-12. 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.

*33-13. 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. Where entry is made through the tank roof, the foam discharge outlet shall be attached to the top angle and there shall be a weak joint between the outlet and roof to permit shifting of the roof without likelihood of injury to the outlet or the possibility of disrupting the foam discharge. This type of construction shall be subject to approval by the inspection department having jurisdiction.

33-20. 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.

33-21. Fixed outlets shall be provided with suitable inspection means to permit proper maintenance and for inspection and replacement of vapor seals.

33-30. FLOATING ROOF TANKS: Fixed outlets are not required on floating roof tanks, horizontal cylindrical tanks or pressure tanks operating at one p.s.i. or higher pressure.

33-40. 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.

33-50. 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 Section IV).

34-00. Piping. (See also §15-00.)

34-10. GENERAL:

34-11. All piping inside of dikes, and within fifty 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.

34-12. Piping, except suction pipe and in other special cases where permitted by the inspection department having jurisdiction, shall be normally empty, being filled in case of fire, or for tests.

34-13. Piping which is normally filled with liquids, such as the suction pipes, shall be protected from freezing when necessary.

34-14. Piping and valves normally in contact with corrosive liquids shall be of corrosion resistant metal or reliably and permanently protected against corrosion.

34-15. Pipes should be arranged to drain (pitch ½ inch in 10 feet) to as few low points as possible and drains shall be provided at each of these low points.

34-16. A suitable swing joint arrangement of standard weight malleable iron or steel fittings, or other suitable means, shall be provided at the base of the tank risers to take care of shock and expansion. At least one flanged or union joint shall be provided in each riser within five feet of the ground to permit of hydrostatic testing up to this joint.

34-17. 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 feet from tanks of 50 feet 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.

34-20. PIPE LINES CARRYING FOAM.

*34-21. 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 inspection department having jurisdiction.

*34-22. 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 square inch 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.

34-30. AIR FOAM SYSTEMS.

*34-31. 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 paragraph §11-55. The point at which the stabilizer is added to the water makes no difference in the foam formation.

34-32. The introduction of foam stabilizer may be accomplished in a central foam house and valved branch lines extended to all protected tanks.

34-33. 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.

*34-34. Air foam pumping units or high back-pressure types of foam makers may be installed at distances up to 600 feet from the protected tank and will deliver air foam under pressure through 4" or 6" pipe to a foam outlet at the top angle.

35-00. Valves. (See also §15-12.)

35-10. All valves, except hydrant valves, shall be of the O.S. and Y. or post indicator type.

35-20. The laterals to each foam chamber shall be separately valved in fixed installations (see §30.24).

35-30. 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.

35-40. Control valves shall be located outside dikes and not less than the following distances from the shell of the tank which they control: 50 feet for tanks less than 50 feet in diameter; one diameter for tanks 50 feet in diameter or larger, except that control valves may be permitted at less than the above distances where adequately protected, subject to the approval of the inspection department having jurisdiction.

35-50. 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.

36-00. Hydrants.

36-10. 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 inspection department having jurisdiction may be provided.

SECTION IV.

PROTECTION OF OUTDOOR STORAGE TANKS BY PORTABLE TOWER SYSTEMS.

40-10. GENERAL: This section 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: This type of system, although not as reliable as systems employing fixed discharge outlets, may be employed in indicated cases, e.g. the protection of low tanks, 30 ft. or less in height, and the protection of horizontal cylindrical tanks. Generally, portable towers are to be regarded as limited in scope and effectiveness, and as not affording the same degree of protection as fixed systems. 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 number and the availability of the men, trucks, etc., is subject to the approval of the authority having jurisdiction.

40-20. DEFINITIONS:

*40-21. 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.

40-22. 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 Section V).

41-00. Rate of Application.

The minimum rate of discharge to portable foam towers shall be as specified in §31-00:

41-10. FOR THE PROTECTION OF TANKS CONTAINING LIQUID HYDROCARBONS: as specified in §§31-11, 31-12, 31-13 and 31-14.

41-20. FOR THE PROTECTION OF TANKS CONTAINING WATER SOLUBLE SOLVENTS: as specified in §31-20.

42-00. Supply of Foam-Producing Materials. (See also §§13-10, 13-20.)

42-10. GENERAL: The minimum total supplies to be maintained shall be the sum of the quantities defined in §§42-20, 42-30, 42-40.

42-20. 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 §41-00 for the following minimum periods of time: (See also A-31-20.)

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 §§30-22 and 30-23 for definitions.

WATER SOLUBLE SOLVENTS		
Products such as methyl, ethyl and isopropyl alcohols, ethyl acetate, etc.	30 min.	50 min.
Products such as isopropyl ether, etc.	30 min.	50 min.
Products such as diethyl ether, etc.	55 min.	65 min.

NOTE: If the apparatus available has a delivery rate higher than that specified in §31-00 proportionate reduction in the time figures given may be made. Tanks containing flammable liquids having a flash point over 200°F. closed cup are not, as a rule, required to be protected by foam.

42-21. DRY POWDER GENERATORS: For the purpose of Section 42-00 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.

42-30. FOAM HOSE STREAMS: The requirements for hose streams shall be as specified in §32-30.

42-40. REQUIREMENTS TO FILL PIPE LINES: These shall be the same as specified in §32-40, if applicable.

43-00. Number of Foam Towers Required.

*43-10. 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 §41-00.

43-11. Tanks up to 65′ in diameter shall have at least one approved foam tower; tanks over 65′ to 117′6″ diameter shall have at least two foam towers; tanks over 117′6″ to 140′ diameter shall have at least three foam towers; tanks over 140′ diameter shall have at least four foam towers.

SECTION V.

PROTECTION OF OUTDOOR STORAGE TANKS BY PORTABLE FOAM HOSE STREAMS.

*50-10. GENERAL: This section relates to systems in which the foam is applied through portable foam hose nozzles.

*50-20. SCOPE: Foam hose streams are usually recommended as auxiliary protection in conjunction with fixed piping systems and portable tower systems. In some cases, however, they are suitable when used alone as in the protection of horizontal cylindrical tanks and vertical tanks not over 30 ft. diameter nor over 20 ft. high.

51-00. Rate of Application.

The minimum rate of discharge to foam hose streams protecting a given hazard shall be as follows:

51-10. FOR LIQUID HYDROCARBONS.

51-11. 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.

51-12. For dry powder foam generator systems the water rate to the generator shall be at least 1.6 GPM for each 10 square feet of liquid surface area to be protected.

51-13. 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 square feet of liquid surface area of the tanks to be protected.

51-14. For highly volatile materials such as casinghead gasoline (25 to 40 lbs. Reid vapor pressure), higher rates of application are required, possibly as high as double the rates specified in §51-11 and §51-12.

51-20. FOR WATER SOLUBLE SOLVENTS.

51-21. For certain water soluble solvents the water rate to foam generators in gallons per minute for each 10 square feet of liquid surface area to be protected shall be as specified in the table below:

	Water Rate gpm/ 10 sq. ft.
Products such as methyl, ethyl and isopropyl alcohols, ethyl acetate, etc.	1.6
Products such as isopropyl ether, etc.	2.1
Products such as diethyl ether, etc.	4.3

51-22. Protection of these water soluble solvents requires the use of alcohol type foam (see paragraph 11-45.30).

52-00. Supply of Foam-Producing Materials. (See also §§13-10 and 32-20.)

52-10. LIQUID HYDROCARBONS, WATER SOLUBLE SOLVENTS: The quantity of foam-producing materials provided shall be sufficient to permit operation of the apparatus at the delivery rates set forth in §51-00 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.

WATER SOLUBLE SOLVENTS

Products such as methyl, ethyl and isopropyl alcohols, ethyl acetate, etc.	50 min.
Products such as isopropyl ether, etc.	50 min.
Products such as diethyl ether, etc.	65 min.

52-11. DRY POWDER GENERATORS: For the purpose of Section 52-00 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.

52-12. 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 §53-20 for a period of at least 30 minutes shall be provided.

53-00. Number of Foam Hose Streams.

*53.10. Foam hose streams shall be available in the proper number and capacity as to deliver foam on the burning liquid surface at a rate to meet the requirements of §51-00.

53-20. 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.

53-21. For tanks less than 65′ diameter: 1 hose stream.

53-22. For tanks 65′ in diameter and larger: 2 hose streams.

53-23. Where more than one horizontal tank is enclosed by a single dike, and the aggregate capacity of the tanks exceeds 35,000 gallons, at least two foam hose streams shall be provided.

53-30. 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.

54-00. Operating Tests.

54-10. Manufacturers shall report test results to users and the inspection department having jurisdiction as follows:

54-11. Water rate to single powder foam generators at 50, 75, and 100 p.s.i. flowing pressure, and powder rate and foam production rate (measured after good foam is discharged from the nozzle) using stated powder delivering through 100 feet of 2½ inch hose and stated nozzle, and foam stream range with water at 70°F.

54-12. For foam solution generators, test similar to §54-11, but with twin 2½ inch solution lines 200 feet long to stated mixing nozzle set, and additional data to include pressure on generator outlet and at the inlet to the mixing nozzle set.

55-00. Unlined Fabric Hose.

55-10. Unlined fabric hose shall not be used with foam equipment.

APPENDIX.

A-11-00. Reference to other standards and publications:

The following publications of the National Fire Protection Association deal with other standards and information related to the use of foam fire protection:

VOLUME I, NATIONAL FIRE CODES, FLAMMABLE LIQUIDS, GASES, CHEMICALS AND EXPLOSIVES.

Flammable Liquids Ordinance (NFPA No. 30-L)
Protection of Tanks in Flooded Regions (NFPA No. 30A)
Rooms, Cabinets and Houses for Storage of Flammable Liquids (NFPA No. 30C)
Concrete Fuel Oil Tanks (NFPA No. 30D)
Petroleum Wharves (NFPA No. 304-L)
Dip Tanks (NFPA No. 34)
Fire Hazard Properties of Flammable Liquids, Gases and Volatile Solids (NFPA No. 325)
Standard Method of Test for Flash Point by Means of the Pensky-Martens Closed Tester (ASTM D 93-46)
Standard Method of Test for Flash Point by Means of the Tag Closed Tester (ASTM D56-36)

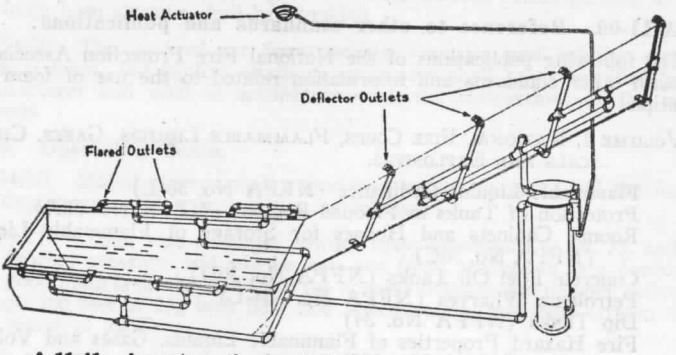
VOLUME IV, NATIONAL FIRE CODES, EXTINGUISHING AND ALARM EQUIPMENT.

Sprinkler Equipments, Installation of (NFPA No. 13)
Gravity and Pressure Tanks (NFPA No. 22)
Centrifugal Fire Pumps, Installation (NFPA No. 20)
Steam Fire Pumps (NFPA No. 21)
Valves Controlling Water Supplies for Fire Protection (NFPA No. 26)
First Aid Fire Appliances (NFPA No. 10)
Outside Protection, Private Underground Piping Systems (NFPA No. 24)
Valves, Indicator Posts and Hydrants (NFPA No. 29)
Fire Hose, Care of (NFPA No. 198)
Fire Hose Couplings (NFPA No. 194)
Small Hose Couplings, Standard (NFPA No. 194B)
Fire Hose, Cotton Rubber-Lined for Public and Private Fire Department Use (NFPA No. 196)
Unlined Linen Fire Hose (NFPA No. 197)
Hydrants, Uniform Marking (NFPA No. 291)
Signaling Systems (Central Station), the Installation, Maintenance and Use of for Watchmen, Fire Alarm and Supervisory Service. (NFPA No. 71)
Signaling Systems, Proprietary, Auxiliary and Local Protective (NFPA No. 72)
Private Fire Brigades, Organization, Drilling and Equipment (NFPA No. 27)

OTHER NFPA PUBLICATIONS:

Handbook of Fire Protection (1948)
Aircraft Rescue and Fire Fighting (NFPA No. 403-T)
Industrial Fire Brigades Training Manual (NFPA No. 621)
Lacquer Manufacturing Plants (NFPA No. 35)

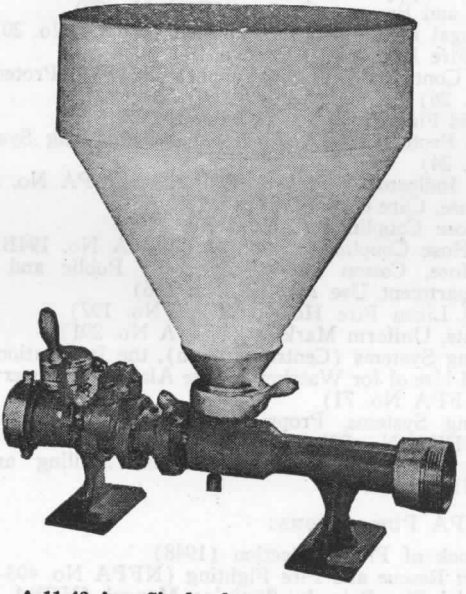
A-11-41. STORED SOLUTION SYSTEMS:



A-11-41. 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 gallon of "A" solution plus 0.5 gallon of "B" solution (a total of one gallon of solutions) produces about eight gallons of foam.

A-11-42. CONTINUOUS FOAM GENERATORS: Figures A-11-42-A and A-11-42-B show the two types of chemical foam generators.



A-11-42-A. Single hopper chemical foam generator of the single powder type.

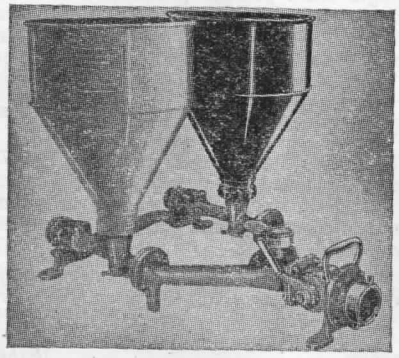


Fig. A-11-42-B. Dual hopper chemical foam generator of the two powder type.

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% of the generator inlet pressure.

A-11-44. 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.

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-11.45. FOAM POWDER.

A-11-45.10. Dual foam powder produces 8 to 12 gallons 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 gallons of foam per gallon of water consumed. (See Notes 1 and 2, A-11-45.30.)

Dual foam powder is packed in pails containing approximately 50 lbs. The pails are distinctively 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-11-45.20. Single foam powder produces 7 to 11.5 gallons 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 gallons of foam per gallon of water consumed. (See Notes 1 and 2, A-11-45.30.)

Single powder is packed in 50-lb. pails which are distinctively marked. The precautions given in A-11-45.10 also apply to single powder chemicals.

A-11-45.30. The special foam powder produces 5 to 7.5 gallons 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 gallons of foam per gallon of water consumed. (See Note 2 below.)

At present this special foam powder is the only foam-producing material known to be effective on fires involving water soluble solvents among which are the following:

Alcohols

Methyl alcohol
Ethyl alcohol
Propyl alcohols
*Butyl alcohols
*Diacetone alcohol

Esters

Methyl acetate
Ethyl acetate

Ethers

Ethyl ether
Isopropyl ether
Amyl ether
Dioxane
Ethyl Cellosolve
Butyl Cellosolve
*Carbitol
*Butyl Carbitol

Ketones

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 above in A-11-45.10 also apply to the "alcohol" type foam chemicals.

NOTE: 1. The foam produced by the powders referred to in A-11-45.10 and A-11-45.20 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.

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-11-50. AIR FOAM:

The air foams now available in the United States (1950) are not suitable for use on fires involving water soluble solvents (defined in §11-45.30) and in some cases may be attacked by solvents for which ordinary chemical foam is entirely suitable. Following is a list of those solvents for which air foam is not considered suitable. This list represents only the extent of current knowledge (1950) and should not be considered as complete.

Alcohols

Methyl alcohol
Ethyl alcohol
Propyl alcohols (all)
Butyl alcohols (all)
Amyl alcohols (all)
Hexyl alcohol
Heptyl alcohol
Octyl alcohol
Nonyl alcohol
Diacetone alcohol

Esters

Methyl Acetate
Ethyl Acetate
Isopropyl Acetate
Butyl Acetate
Amyl Acetate

Ketones

Acetone
Methyl Ethyl Ketone
Methyl Acetone (syn.)
Methyl Isobutyl Ketone
Methyl n-Amyl Ketone
Acetonyl Acetone

Ethers

Ethyl Ether
Isopropyl Ether
Butyl Ether
Dioxane
Cellosolves
Carbitols

A-11-51. 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.

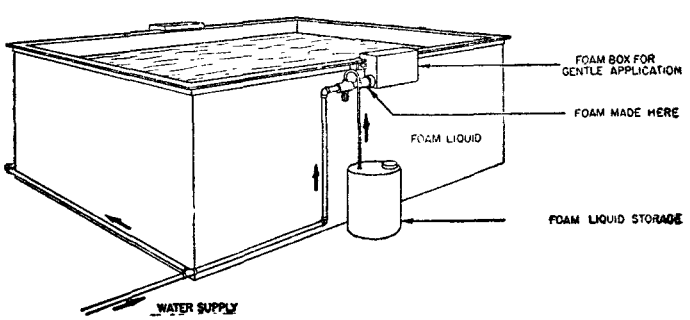


Fig. A-11-51. Schematic diagram showing protection of dip tanks with air foam system. Foam liquid (stabilizer) storage in vessel beside dip tank.

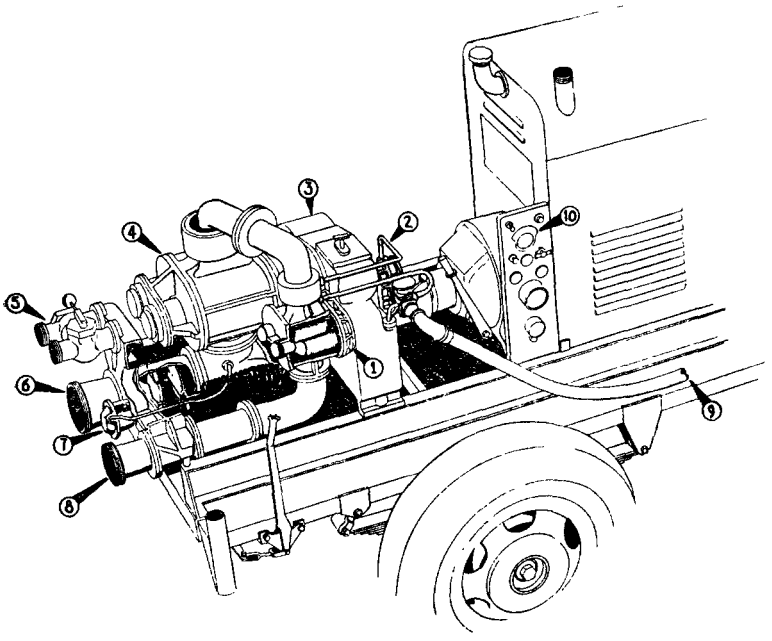


Fig. A-11-52. Air Foam Pump.

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

A-11-52. AIR FOAM PUMPS: Fig. A-11-52 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 2—2½ in. hose connections (5).

This machine delivers foam through the foam outlet or the 2½ inch 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 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-11-53. AIR FOAM HOSE STREAM NOZZLES:

Fig. A-11-53. Air Foam Playpipe.

A-11-54. AIR FOAM STABILIZER: The "high expansion" type stabilizer produces about 350 gallons of air foam per gallon of stabilizer and 16 to 18 gallons of air foam per gallon of water. The "low expansion" type of stabilizer produces 120 to 200 gallons of air foam per gallon of stabilizer and 8.5 to 11.5 gallons 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-11.55.11. PREMIXED AIR FOAM SOLUTIONS: The manufacturer should be consulted regarding stabilizer to be used in the preparation of pre-mixed solution.

A-11-55.21. PUMP SUCTION METHOD: This type of proportioner (Fig. A-11-55.21) 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% to 200% of the nominal or rated capacity as prescribed by the manufacturer.

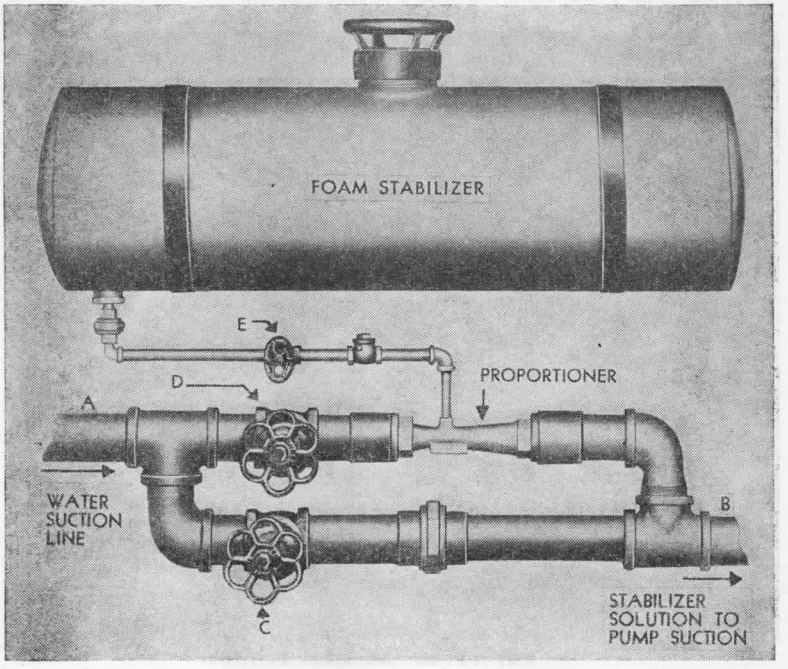


Fig. A-11-55.21. Pump Suction Proportioner. To install: connect A to water suction line, connect B to suction side of pump. To operate foam system: close valve C, open valves D and E. To discharge plain water: close valves D and E, open valve C.

A-11-55.22. 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 gauge 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.

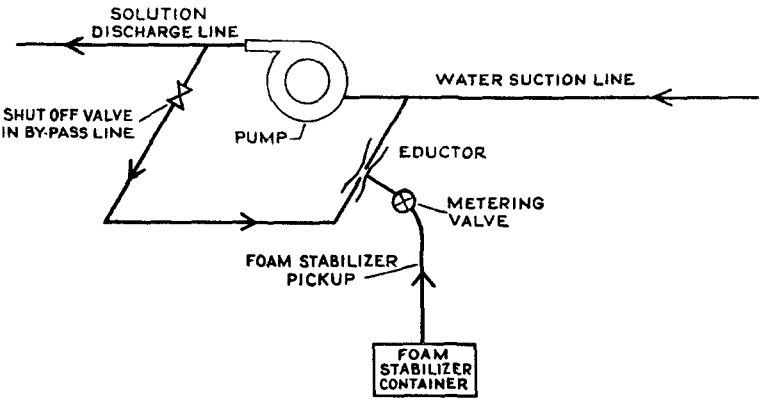


Fig. A-11-55.22. Around-the-Pump Proportioner.

A-11-55.31. PRESSURE PROPORTIONING TANK METHOD:

The arrangement of these devices may take a variety of forms. A single tank or a 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-11-55.31B 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% to 200% 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.

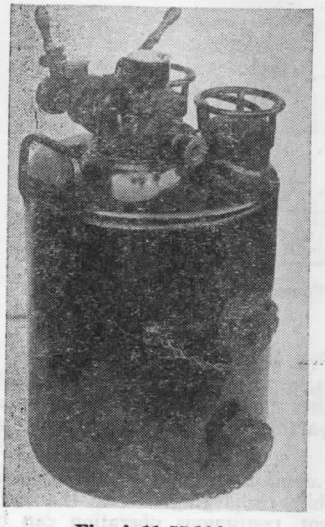


Fig. A-11-55.31A.
Pressure Proportioner, Compartmented Single Tank.

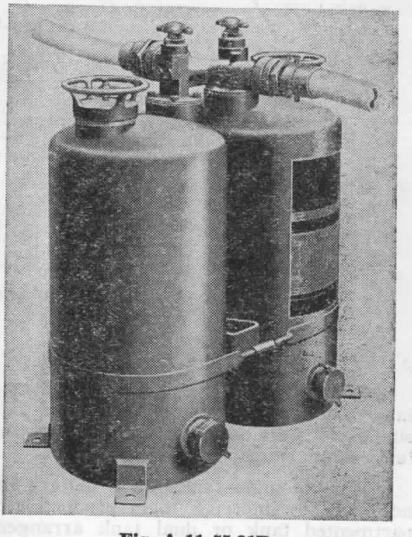


Fig. A-11-55.31B.
Pressure Proportioner, Dual Tank.

A-11-55.32. IN-LINE INDUCTOR: This inductor is for installation in a hose line, usually at some distance from the foam maker or play pipe, 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.

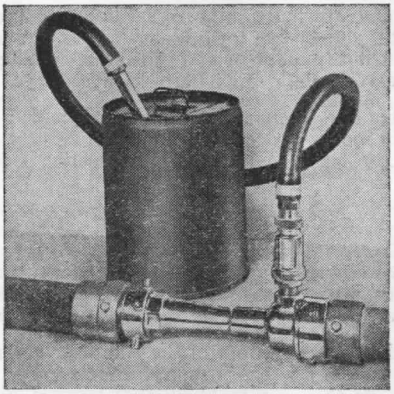


Fig. A-11-55.32. In-Line Inductor.

A-11-55.33. 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-11-55.33.

The unit consists of two inductors designated as the primary inductor and the secondary inductor. The primary inductor is located outside the

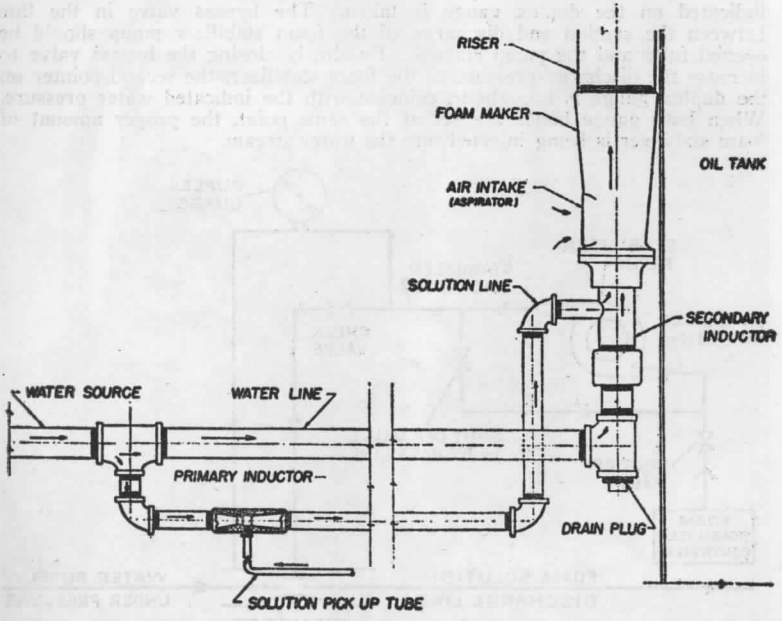


Fig. A-11-55.33. Air Foam Auto-Induction System. Solution pick-up tube picks up stabilizer from its container.

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-11-55.34. 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 gauge 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 gauge is brought to coincide with the indicated water pressure. When both gauge hands are set at the same point, the proper amount of foam stabilizer is being injected into the water stream.

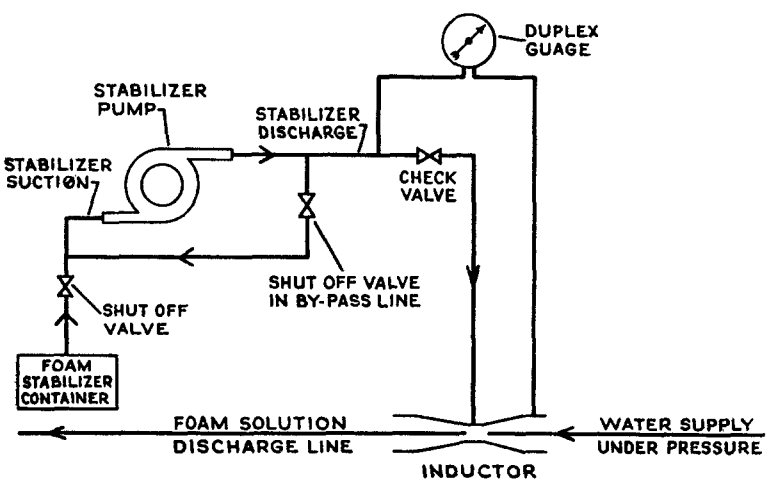


Fig. A-11-55.34. Pressure Side Proportioner.

LIMITATIONS:

1. The capacity of the proportioner may be varied from approximately 50% to 200% 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-11-55.35. 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% at 100 psi. It is manufactured only in certain ranges of approximately two times the minimum, i.e., 60-150 gpm, 250-500 gpm, and 500-1,000 gpm. It has no limitations with respect to pressure and correct proportioning. The volume of water flow governs the volume of stabilizer delivered into the water stream.

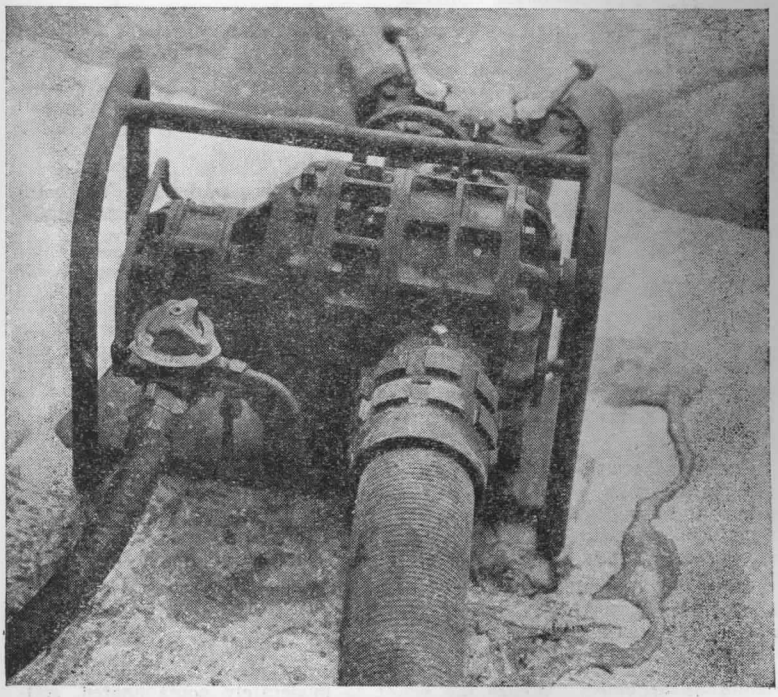


Fig. A-11-55.35. Water Motor Proportioner.

A-11-55.41. BUILT-IN INDUCTOR IN FOAM MAKER: Figures A-11-51 and A-11-53, 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.

A-12-13. 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-12-20: 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 boiling point of water. The water in the foam may cause violent frothing of the contents and even the forceful expulsion of a portion of the contents.

Foam, even though a poor conductor of electricity, is not recommended for use on fires involving electrical equipment where it 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.

A-13-20. 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-13-40. 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. The manufacturer and the inspection department 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° F. and 100° F.

A-13-43. 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-14-40. WET STORAGE CHEMICAL FOAM SYSTEMS:

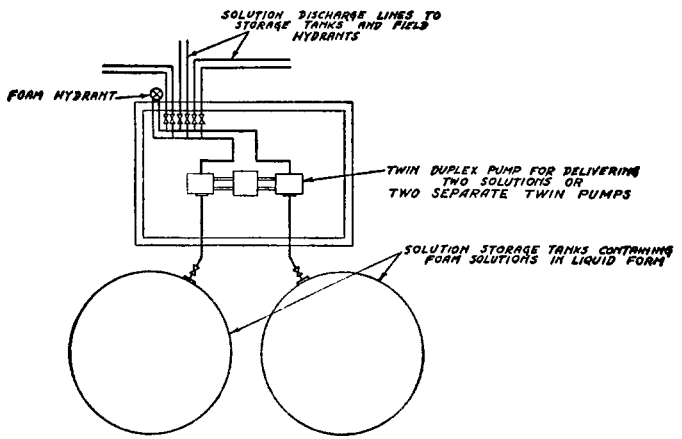


Fig. A-14-40. Typical two solution (acid and basic) chemical foam system layout. Discharge line layout similar to that for two powder type shown in A-14-52B.

A-14-42. 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-14-45. This usually requires a twin duplex pump or two identical pumps operated from a common prime mover.

A-14-52. CENTRALIZED FIXED PIPING SYSTEMS:

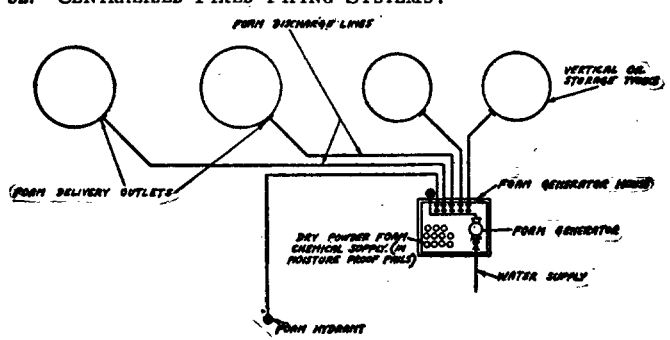


Fig. A-14-52A. Typical chemical foam generator system layout of the single powder type.

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

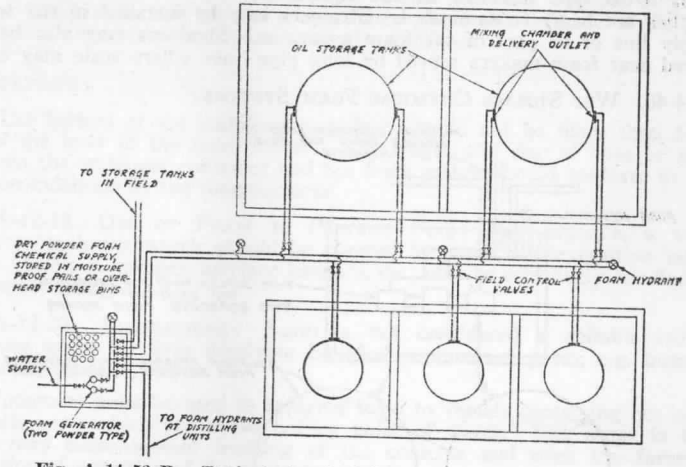


Fig. A-14-52-B. Typical chemical foam generator system layout of the two powder type.

A-14-52.10. DUAL POWDER GENERATOR SYSTEM WITH POWDER IN BINS:

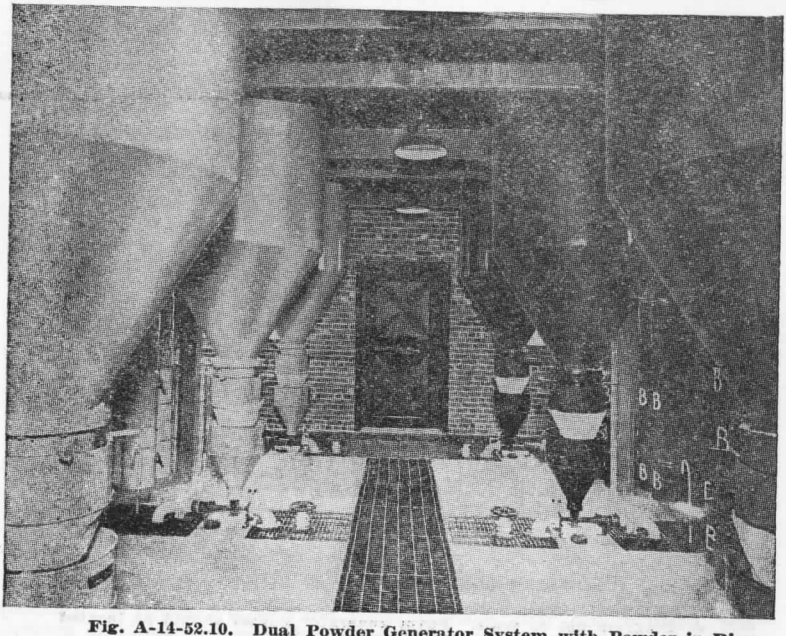


Fig. A-14-52.10. Dual Powder Generator System with Powder in Bins.

A-14-52.20. 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.

A-14-60. AIR FOAM SYSTEMS:

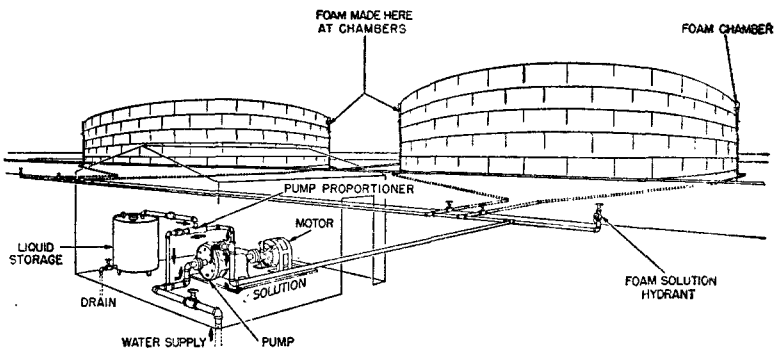


Fig. A-14-60. Schematic arrangement of air foam protection for storage tanks. Liquid storage indicated lower left of illustration is stabilizer storage.

A-18-30. DISCHARGE TESTS: The foam discharged from the delivery equipment (foam chamber, portable tower, pipe or nozzle) shall be of good quality as defined in §11-30. 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 following tests are suggested:

STANDARD FIRE TEST—FOAM.†

PURPOSE: The purpose of this test is to provide an index to the fire extinguishing properties of foam, its resistance to flame attack and its ability to form a protective blanket.

FIELD TESTS FOR AIR FOAM QUALITY.

PURPOSE: These tests permit evaluation of the quality of the foam discharged from an air foam apparatus or system. If the foam has passed the standard fire test for foam†, these laboratory-type tests provide rapid and simple means of verifying that the apparatus, as installed, may be expected to produce foam of fire-fighting quality.

†The details of specifications for a Standard Fire Test for Foam have been referred (1949) to the appropriate testing laboratories for clarification.

Two tests are specified, the expansion test and the drainage test, and both must be made to permit a satisfactory evaluation.

EXPANSION TEST: The expansion value may be defined as the reciprocal of the specific gravity of the foam and also the ratio of the final foam volume to the original water volume.

The container used for sampling shall be 2" deep by 7⅜" I.D. (volume-1400 millilitres), preferably made from aluminum or plastic, about 1/16" thick to eliminate dead weight. In the bottom, at the edge, a ¼" drain tube with suitable cock shall be provided (see Fig. A-18-30-A). The container, with fittings, should be carefully tared, and this weight, in grams, recorded.

The foam sample for this test is to represent as nearly as possible, the foam reaching the surface of the fire, i.e., it must be taken with a minimum of splashing or agitation which would entrain additional air. In some cases, this may be conveniently accomplished by tapping a line carrying foam with a ¼" sampling line and valve to throttle the flow. In sampling from portable nozzles, the most satisfactory method is to discharge foam onto the ground in a normal manner and then IMMEDIATELY afterward scoop the foam sample from the pile.

When the container has been filled, any excess foam should be struck off to insure that the sample is of the correct volume, also any foam clinging to the outside of the container must be wiped off. After the sample

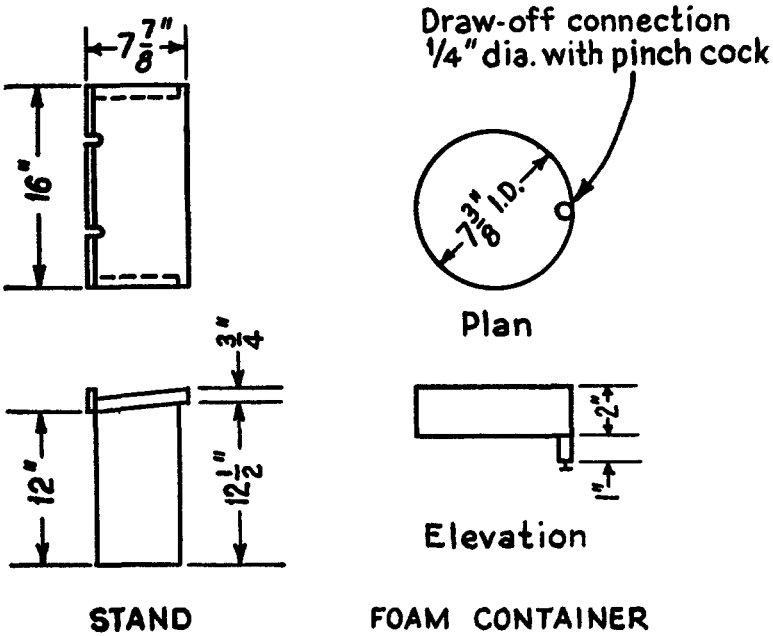


Fig. A-18-30-A. Container for Expansion Test.

has been obtained as directed above, it should be carefully weighed. The difference between the weights gives the weight of the sample volume of 1400 ml., and from these values the expansion is determined as follows:

$$\frac{1400}{\text{(full wt. minus empty wt.)}} = \text{expansion}$$

(Weights to be expressed in grams.)

DRAINAGE TEST: The rate at which the solution drops out of the foam mass is expressed as the drainage rate and is a direct indication of the degree of mixing and stability of the foam. It may be conveniently determined by using the same sample as was weighed for the expansion determination. The pan is placed on a stand, as shown in Fig. A-18-30-A, and the drained solution drawn off at one minute intervals into a graduated cylinder, zero time being taken as the time at which the foam sample was obtained. Readings are continued over approximately a ten-minute period to obtain a time-solution volume curve. (See Fig. A-18-30-B.) The desired final value in this case is the time taken to drain 25% of the total solution volume contained in the sample. The 25% volume in millilitres is readily found by dividing weight of the foam sample in grams by four. Then, by interpolation from the time-solution volume data, the time for the draining of 25% of the solution can be found. This value is called the "25% Time."

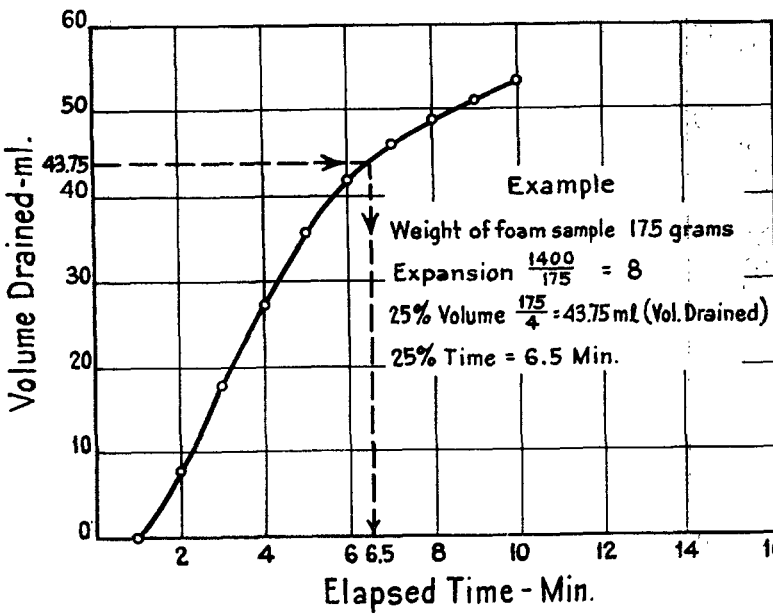


Fig. A-18-30-B. Typical Time-Solution Volume Curve for Determining 25% Time.