

NFPA
11C

6/19/84

ANSI / NFPA 11C
An American
National
Standard
November 20, 1980

MOBILE FOAM APPARATUS 1980



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4M-1-81-FP
Printed in U.S.A.

NATIONAL FIRE PROTECTION ASSOCIATION, INC.
Batterymarch Park, Quincy, MA 02269

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Standard for Mobile Foam Apparatus

NFPA 11C-1980

1980 Edition of NFPA 11C

This 1980 edition of NFPA 11C was prepared by the Technical Committee on Foam and was adopted by the National Fire Protection Association, Inc. at its Fall Meeting in San Diego, California on November 20, 1980. It was released by the Standards Council on December 10, 1980.

It has been approved by the American National Standards Institute.

Origin and Development of NFPA 11C

The need for a Standard for Mobile Foam Apparatus was brought to the attention of the Foam Committee by several members affiliated with petroleum and chemical companies. The lack of a national standard had made designing, building and purchasing a foam truck an expensive undertaking, sometimes resulting in substandard fire protection. Recognizing the need for the standard, and with the approval of the Standards Council, work on the standard was started in 1978 and adopted at the 1980 Fall Meeting.

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Standard for Mobile Foam Apparatus

NFPA 11C-1980

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A. Information on referenced publications can be found in Appendix B.

Chapter 1 Introduction

1-1 Scope. This standard applies to mobile foam apparatus (not hand-drawn) used for the control and extinguishment of flammable and combustible liquid fires in storage tanks, and other locations involving the risk of spills of flammable liquids. It covers the special systems and equipment necessary to produce foam and the requirements of the vehicle carrying the equipment. With respect to automotive apparatus this standard is intended to supplement NFPA 1901, *Standard for Automotive Fire Apparatus*. The specific design and application requirements of foam for special hazard protection are defined in NFPA 11, *Standard for Foam Extinguishing Systems*, NFPA 11A, *Standard for High Expansion Foam Systems*, and NFPA 11B, *Standard on Synthetic Foam and Combined Agent Systems*. Requirements for airport crash rescue vehicles are covered in NFPA 414, *Standard for Aircraft Rescue and Fire Fighting Vehicles*, and are not included in this standard.

1-2 Purpose. This standard is intended for the use and guidance of persons charged with designing, purchasing, approving, testing, inspecting, operating or maintaining mobile foam apparatus and is based upon sound engineering principles, test data and field experience. Nothing in this standard is intended to restrict new technologies or alternate arrangements providing the level of safety prescribed by the standard is not lowered.

1-3 Units. Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). One unit (liter), outside of, but recognized by SI, is commonly used in international fire protection. The units are listed in Table 1-3 with conversion factors.

Table 1-3

Name of Unit	Unit Symbol	Conversion Factor
meter	m	1 ft = 0.3048 m
centimeter	cm	1 ft = 30.48 cm
millimeter	mm	1 in. = 25.40 mm
liter	L	1 gal = 3.785 L
liter per minute	L/min	1 gpm = 3.785 L/min
cubic decimeter	dm ³	1 gal = 3.785 dm ³
pascal	Pa	1 psi = 6894.757 Pa
bar	bar	1 psi = 0.0689 bar
bar	bar	1 bar = 105 Pa
kilopascal	kPa	1 psi = 6.895 kPa
kilowatt	kW	1 HP = 0.746 kW

1-4 Definitions. The following definitions apply to terms used in this standard. Refer to NFPA Standards 11, 11A, 11B, and 1901 for other definitions and further explanation.

Approved. Means "acceptable to the authority having jurisdiction."

NOTE: The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office, or individual responsible for "approving" equipment, an installation, or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local, or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, electrical inspector, or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the "authority having jurisdiction." In many circumstances the property owner or his designated agent assumes the role of the "authority having jurisdiction"; at government installations, the commanding officer or departmental official may be the "authority having jurisdiction."

Concentration. The percent of foam concentrate contained in a foam solution. The type of foam concentrate being used determines the percentage of concentration required. A 3 percent foam concentrate is mixed in the ratio of 97 parts water to 3 parts foam concentrate to make foam solution. A 6 percent concentrate is mixed with 94 parts water to 6 parts foam concentrate.

Discharge Device. A fixed or portable device which directs the flow of foam to the fire or flammable liquid surface.

Eductor. See "Inductor."

Expansion. The ratio of final foam volume to original foam solution volume before adding air.

Expellant Gas. Usually nitrogen under pressure used to expel the premixed foam solution from a tank through a discharge system. Carbon dioxide or dry air under pressure may be used.

Foam (Air Foam or Mechanical Foam). Fire fighting foam within the scope of this standard is a stable aggregation of small bubbles made by mixing air into a water solution containing a foam concentrate by means of suitably designed equipment. Foam has a lower density than oil or water, and shows tenacious qualities for covering and clinging to vertical or horizontal surfaces. It flows freely over a burning liquid surface and forms a stable, air-excluding continuous blanket to seal volatile flammable vapors from access to air. It resists disruption due to wind and draft, or heat and flame attack, and is capable of resealing in case of mechanical rupture. Fire fighting foams retain these properties for relatively long periods of time.

Foam Concentrate. The liquid foaming agent as received from the manufacturer and used for mixing with the recommended amount of water and air to produce foam. This term as used in this standard includes concentrates of the following types: protein foam, fluoroprotein foam, aqueous film forming foam (AFFF), and other synthetic foams.

Foam Solution. A homogeneous mixture of water and foam concentrate in the proper proportion.

Inductor. A proportioning device that employs a venturi in a water line to create a reduced pressure in piping leading from a supply of concentrate so that the concentrate is automatically mixed with water in the required proportion.

In-line Inductor. A venturi inductor, located in the water supply line to the foam maker to create a reduced pressure in piping

leading from a supply of concentrate so that the concentrate is automatically mixed with water in the required proportion. It is precalibrated and it may be adjustable.

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Listed. Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The "authority having jurisdiction" should utilize the system employed by the listing organization to identify a listed product.

Premix Solution. A foam solution made by mixing foam concentrate and water in proper proportion and stored ready for use.

Premix Tank. A tank for storage of premix foam solution. Premix tanks are employed on mobile foam apparatus designed to operate without an external water supply.

Shall. Indicates a mandatory requirement.

Should. Indicates a recommendation or that which is advised but not required.

1-5 Description. Mobile foam apparatus is an automotive vehicle or trailer designed to transport, produce, and apply foam to fires or to a potential fire hazard. Such apparatus comprises one or several of the following components: foam concentrate supply tanks, premix solution supply tank, foam concentrate proportioning system, water pump, portable foam discharge devices, fire hose and foam monitors. The following chapters contain general requirements applicable to different kinds of foam systems and also specific requirements for the type of systems generally used. The final chapter covers acceptance tests.

Chapter 2 General Requirements

2-1 General.

2-1.1 Clarification. The following provisions supplement or modify requirements of NFPA 1901, *Standard for Automotive Fire Apparatus*, Chapter 1.

(a) Chassis Carrying Capacity. NFPA 1901, *Standard for Automotive Fire Apparatus*, is amended to include consideration of the weight of any additional equipment required by this standard, including, but not limited to, the weight of additional tanks or containers, when full.

(b) Tank Requirement. No stipulation in NFPA 1901, *Standard for Automotive Fire Apparatus*, shall be construed to require a mobile foam apparatus to be equipped with a water tank in addition to foam concentrate and/or premix solution tanks.

2-1.2 Materials. The materials used in the foam system shall be compatible with the foam concentrate or premix to be carried on the apparatus. Components of the system which can be flushed after use can be constructed of any material that will resist corrosion from water and has the structural strength necessary for the application intended.

2-2 Tanks.

2-2.1 Mounting. Any tank shall be mounted in the mobile apparatus in such fashion that it may be removed and re-installed without cutting, burning, or welding.

2-3 Nameplates and Markings. All required permanent nameplates and markings shall be capable of withstanding the effects of extremes of weather and temperature and shall be securely attached and installed as to be protected against mechanical injury.

2-3.1 Instruction Plate. The manufacturer shall provide an instruction plate, affixed to the apparatus at the operator's position, stating the conditions under which the foam system will operate effectively. The instruction plate shall include a schematic diagram of the system and general operating instructions.

2-3.2 Controls. The function and operation of controls, operating devices, gages, and drains shall be clearly identified and shall be accessible.

2-4 Performance. The foam system shall be designed to deliver foam solution within the limits established for the listed devices in the system.

2-5 Hose Connections.

2-5.1 Threads. All hose connections 1½-in. and larger shall conform to the American National Fire Hose Connection Screw Thread as specified in NFPA 1963, *Standard for Screw Threads and Gaskets for Fire Hose Connections*. Adapter couplings, securely attached, shall be provided where hose connectors required by local law or custom differ from the American National Fire Hose Connection Screw Thread.

2-5.2 Caps and Plugs. All male hose connections not supplied with preconnected hose shall be provided with protective caps. All female hose connections shall be provided with plugs.

2-6 Control Valves. All control valves shall be of a type which open and close smoothly and readily under all rated pressures, shall effectively shut off the portions of the system they control, and shall be sized commensurate with the maximum flow and pressure required by the portions of the system they control.

2-7 Drains. The piping system shall be provided with sufficient drains so that all foam concentrate, foam solution, or water (after flushing) can be drained from the system.

2-8 Apparatus Operator's Position. Operating controls, gages and other instruments shall be grouped in one area of the apparatus to be known as the operator's position. The design of the operator's position shall be such that the operator can, without changing his position, see all gages and instruments and manipulate all controls.

2-8.1 Water Pump. If the apparatus is equipped with a water pump, requirements of NFPA 1901, *Standard for Automotive Fire Apparatus*, Chapter 3 shall apply in addition to the requirements of this chapter.

2-9 Temperature. Optimum foam production is obtained using water at temperatures between 40°F (4.4°C) and 100°F (37.8°C). Higher or lower water temperatures may reduce foam efficiency. Foam concentrates and premix solution are subject to freezing and shall be stored within listed temperature limitations.

Chapter 3 Balanced Pressure Proportioning System

3-1* General.

3-1.1 Description. The most versatile method of proportioning foam concentrate into the water stream is through a balanced pressure proportioning system. Once in operation, this system automatically proportions foam concentrate over a wide range of flows and pressures without manual adjustments.

3-1.2 Components. The system consists of a foam concentrate storage tank, positive displacement type foam concentrate pump, and proportioning system. A typical system is illustrated in Figure A-3-1.

3-1.3 Operation. The principle of operation is based on the use of a pressure regulating diaphragm control valve, an orifice, and/or venturi. The pressure regulating diaphragm control valve is used to obtain foam concentrate pressure equal to the water discharge pressure. The orifice is used to meter the foam concentrate at the prescribed proportioning rate. The orifice may be replaced with an adjustable metering valve to allow different proportioning rates. Identical inlet pressures at the venturi throat and the orifice (metering valve), for accurate proportioning over a large range, are obtained automatically by the use of the pressure regulating diaphragm control valve.

3-1.4 Capacity. Guidelines to determine the required capacity of a system depending on the hazard to be protected are found in NFPA 11, *Standard for Foam Extinguishing Systems*, and 11B, *Standard on Synthetic and Combined Agent Systems*.

3-1.5 Truck Engine Brake Horsepower Requirement. When the truck is equipped with a water pump, the engine shall develop a net brake horsepower output (at design speed after allowance for auxiliary drives, transmission gear losses, and correction for specific altitude) of at least 110 percent of the power required by the water pump, the foam concentrate pump, and the transfer and power take-off gear losses when operating at design conditions, under continuous operation without overheating.

3-2 Atmospheric Foam Concentrate Tank.

3-2.1 Construction. The tank shall be constructed of a minimum 12 U.S. gage (2.75 mm) welded carbon steel, stainless steel, or glass

reinforced plastic having equivalent structural characteristics. The tank shall be sized to provide at least a 2-minute supply at the rated capacity of the foam concentrate pump.

3-2.1.1 Swash Partitions. A sufficient number of swash partitions to minimize foaming and to provide road stability shall be provided so that the maximum dimension of any space in the tank, either transverse or longitudinal, shall not exceed 46 in. (1168 mm) and shall not be less than 23 in. (584 mm). Swash partitions shall have suitable vents or openings at both top and bottom to permit movement of foam concentrate between spaces as required to meet the flow requirements of the system and permit drainage of the entire tank contents to the sump.

3-2.1.2 Access. Access shall be provided for inspection and cleaning of the tank interior.

3-2.1.3 Expansion Dome. An expansion dome with a volume not less than 2 percent of the total capacity of the foam concentrate tank shall be installed on top of the tank. The foam concentrate surface area within the expansion dome shall be kept to a minimum with regard to design limitations. The dome cover hatch may be used for gaging, venting, hand filling and inspection.

Exception: Foam concentrate tanks containing 100 gal (380 L) or less do not require an expansion dome.

3-2.1.4 Sump. A sediment sump shall be provided in the bottom of the foam concentrate tank. An internal baffle shall be located directly over the sump to reduce the possibility of vortexing the foam concentrate when withdrawing liquid at a low level.

Exception: Foam concentrate tanks containing 100 gal (380 L) or less do not require a sump.

3-2.2 Connections. The foam concentrate tank shall be provided with at least one outlet, one inlet, one drain connection, and one fill hatch. The size of the connections shall be determined by capacity requirements of the foam system.

3-2.2.1 Outlet (Pump Suction). The pump suction (outlet) shall be installed in the sediment sump so that it is above the normal layer of sediment which may accumulate in the sump.

3-2.2.2 Inlet (Return and Fill Line). The inlet (return and fill line) shall be installed so that the discharge is piped to within 1 in. (25.4 mm) of the tank bottom, to reduce the possibility of foaming when the liquid level is low.

3-2.2.3 Hatch. The hatch shall be hinged, airtight when closed, and include a locking device. The hatch opening shall have a removable screen and be sufficient so as to facilitate refilling the tank by hand from 5 gal (18.9 L) pails.

3-2.2.4 Drain. A valved drain shall be installed at the bottom of the sump.

3-2.3 Pressure Vacuum Vent. A pressure vacuum vent shall be provided on the top of the expansion dome. An internal baffle shall be installed to protect the pressure vacuum vent from surging foam concentrate when the apparatus is in motion. Foam concentrate, if allowed to contact the pressure vacuum vent, will dry and render the device inoperative, which could result in rupture or collapse of the tank.

3-3 Foam Concentrate Pump.

3-3.1 General. The foam concentrate pump shall be mounted permanently on the apparatus to pump foam concentrate from a tank installed on the apparatus, or any other container. The system design shall permit flushing the foam concentrate pump with water after each use.

3-3.2 Performance. The foam concentrate pump shall deliver the flow and pressure required when the system is operating at maximum capacity with reserve capacity allowing for control and losses such as friction, reduced pump efficiency, and valve leakage.

3-3.3 Suction Capability. The foam concentrate pump shall be able to draft foam concentrate from any container at a maximum lift of 5 ft (1.5 m) and at a minimum horizontal distance of 20 ft (6 m) without the aid of an auxiliary priming system.

3-3.4 Construction.

3-3.4.1 Type. The foam concentrate pump shall be a positive displacement type constructed of materials compatible with foam concentrates and water. Foam concentrate pump components which come in contact with the concentrate shall not require lubrication other than the concentrate. Most petroleum based lubricants will contaminate foam concentrate.

3-3.4.2 Pulsations. The foam concentrate pump shall be free from vibration and pressure pulsation when in operation at all speeds.

3-3.5 Relief Valve. A preset relief valve of a type that has an integral mechanical pressure adjustment shall be provided. The relief valve shall be rated at the maximum capacity of the foam concentrate pump. The relief valve shall be installed between the foam concentrate pump discharge and suction, not the foam concentrate tank, to avoid the possibility of introducing water into the foam concentrate while flushing the system.

3-3.6 Strainer. A "Y" type strainer with blow-off valve shall be provided in the foam concentrate pump suction. The strainer shall have a ratio of open basket area to inlet pipe area of at least 10 to 1.

3-3.7 Drive Train. The components in the foam concentrate pump power takeoff drive train shall be capable of transmitting the power required by the pump under maximum design conditions.

3-3.8 Controls. Provisions shall be made for quickly and easily placing the pump in operation. A visual and/or audible signaling device shall be provided at the driver's position to indicate when the power takeoff (PTO) mechanism is engaged.

3-4 Proportioning System.

3-4.1 Components. A typical balanced pressure proportioning system consists of a diaphragm control valve, venturi proportioner (water orifice), a foam concentrate metering valve or orifice, additional valves, connecting pipe, and hose connections.

3-4.1.1 Foam Concentrate Tank Shutoff Valves. Shutoff valves shall be installed in the inlet and outlet lines to the foam concentrate tank. They shall be quick opening ball type and shall provide unrestricted flow and positive shutoff.

3-4.1.2 Pipe and Fittings. The pipe and fittings between the shutoff valves and the foam concentrate tank shall be constructed of material of equal or greater corrosion resistance than the tank material.

3-4.1.3 Pressure Balancing Valve. A diaphragm control valve shall be installed in the foam concentrate return line to the concentrate tank which will automatically balance the pressure of the foam concentrate system with the water. The diaphragm control valve shall operate smoothly without excessive hydraulic hammer or mechanical vibration at all designed flows and pressures.

Its installation shall be accomplished with unions or flanges allowing the valve to be removed for repair. The diaphragm material shall be compatible with the foam concentrate to be used.

(a) Shutoff valves shall be provided on both the water and foam concentrate pressure sensing lines to the diaphragm control valve.

(b) Accessible drains shall be provided for the diaphragm control valve to assure both the foam concentrate and water chambers can be flushed and drained after use.

3-4.2 Pressure Balancing By-Pass. By-pass valves and piping shall be provided allowing the operator to shut off the flow of foam concentrate to the diaphragm control valve and to manually control the proportioning system using a by-pass valve.

3-4.2.1 By-Pass Valve Capacity. The by-pass valve shall be able to by-pass the maximum capacity of the foam concentrate pump.

3-4.2.2 By-Pass Valve Adjustability. The by-pass valve shall be of a design that is suitable for throttling.

3-4.2.3 By-Pass Valve Control Location. Control for the diaphragm controlled valve bypass valve shall be at the operator's position so that the operator can adjust the by-pass valve and see the duplex gage at the same time.

3-4.3 Venturi Proportioner. Venturi proportioners are installed in the discharge side of the water system. Single or multiple venturi flow proportioners may be provided.

3-4.3.1 Pressure Drop. Venturi proportioners shall be of a design that will minimize pressure drop when operating at the designed flows and pressures.

3-4.4 Venturi Proportioner Foam Concentrate Control Valves. A shutoff valve shall be installed between the foam concentrate pump and the foam concentrate connection to each venturi proportioner. The shutoff valve shall open and close smoothly under all pressures. The seat material shall not swell or cause sticking from contact with foam concentrate.

3-4.4.1 Metering Valve. Metering valve proportioning rate graduations shall be easily read and adjusted. Adjustable flow (metering) shutoff valves may be provided in lieu of standard shutoff valves to control the flow of foam concentrate to the venturi proportioners. The metering valve shall open and close smoothly under all pressures, and shall be suitable for use with foam concentrate.

3-4.4.2 Valve Identification. When more than one concentrate shutoff valve or metering valve is required, each valve shall be clearly identified to indicate which venturi proportioner it controls.

3-4.5 Check Valves. Check valves shall be installed between the venturi proportioners and the proportioner shutoff valves.

3-5 External Concentrate Connections.

3-5.1 External Supply and Flushing. Two valved connections shall be provided for use with an external foam concentrate supply and for flushing the system with water after use.

3-5.1.1 Inlet Connection. The inlet connection shall be installed between foam concentrate tank outlet shutoff valve and the strainer. (See *Figure A-3-1.*) It shall be designed for use with vacuum and shall not leak air.

3-5.1.2 Outlet Connection. The outlet connection shall be installed on the discharge side of the foam concentrate pump. (See *Figure A-3-1.*)

3-6 Gage. A duplex gage equipped with a single scale and two needles shall be provided where readily visible from the pump operator's position. The needles shall indicate water pressure and foam concentrate pressure simultaneously. Range of the duplex gage shall be at least 300 psi (2068 kPa) but not more than 600 psi (4136 kPa); size shall be not less than 4½ in. (114 mm) diameter.

3-6.1 Individual discharge pressure gages required by NFPA 1901 are not required for mobile foam apparatus unless specified.

3-7 Twin Suction Device.

3-7.1 Pickup Tubes. Twin pickup tubes shall be provided to draw foam concentrate from pails or drums using the foam concentrate pump.

3-7.1.1 Construction. The two pickup tubes shall be constructed of hard suction hose, each being not less than 15 ft (4.5 m) long. One end of each pickup tube shall terminate in a ball valve on each side of a siamese coupling which will mate with the foam system external inlet connection. The other end of each pickup tube shall be fitted with a rigid tube less than 2 in. (51 mm) outside diameter and not less than 36 in. (914 mm) long. The tube ends are intended to fit into the standard 2 in. (51 mm) opening on a 55 gal (208 L) drum. The end of each tube shall be cut on a bias or some other suitable means to prevent suction restriction between the end of the tube and the bottom of the drum. By alternate use of each pickup tube, drums can alternately be emptied without damage to the foam concentrate pump due to stoppage of flow.

Chapter 4 Around-the-Pump Proportioning System

4-1* General.

4-1.1 Use. The around-the-pump proportioning system is not recommended where water is supplied to the pump suction under pressure from hydrants or other pressurized water source. A small positive pressure at the pump suction can cause reduction in the quantity of concentrate educted. For proper operation, the suction head shall be essentially zero gage pressure or on the vacuum side. It is suitable for automotive fire apparatus equipped with a water pump and water tank. This method is often used where a water tank is not furnished and a water pump is required to draft water for foam system operation and where flows are known and within a limited range. The system can be used to retrofit mobile equipment to provide foam fire fighting capability.

4-1.2 Description. The proportioning system employs an educting-type device, installed in a bypass line between the discharge and suction of a water pump, as illustrated in Figure A-4-1. A small portion of the discharge of the water pump flows through the eductor and draws the required quantity of concentrate from a foam concentrate storage tank, or container, delivering the mixture to the pump suction.

4-1.3 Operation. The quantity of concentrate drawn into the water line is controlled by a manually set metering valve located between the eductor and the foam concentrate storage tank. If the flow rate is varied, operator adjustments must be made.

4-1.4 Components. A typical system installed on automotive fire apparatus consists of an eductor and foam metering valve installed on bypass piping around-the-pump with connecting piping between the foam concentrate storage tank and the eductor.

4-2 Water System.

4-2.1 Water Pump. The water delivery rates and pressures required for the foam proportioning system shall be provided by a pump, installed on the apparatus and meeting the requirements of NFPA 1901, *Standard for Automotive Fire Apparatus*, Chapters 3 or 5, respectively, depending on the required rate.

4-2.2 Drains. Provisions shall be made to drain the water pump and all water piping.

4-3 Proportioning System.

4-3.1 Capacity. The capacity of the foam proportioning system, and the size of the eductor, shall be based on the water pump delivery rates. Guidelines for determining the required capacity are found in NFPA 11, *Standard for Foam Extinguishing Systems*, and NFPA 11B, *Standard on Synthetic Foam and Combined Agent Systems*, based on the specific hazards that will be encountered.

4-3.2 Foam Proportioner. The eductor-type proportioner shall be installed in the bypass piping around the water pump so that the discharge from the eductor connects with the suction side of the pump.

4-3.3 Control Valves.

4-3.3.1 A shutoff valve shall be provided in the bypass system between the water pump discharge manifold and the water inlet to the eductor.

4-3.3.2 A shutoff valve and foam metering valve shall be provided in the foam concentrate tank connection to the eductor.

4-3.3.3 A check valve shall be provided between the foam concentrate metering valve and the eductor to protect the foam concentrate from water dilution due to operator error or a malfunction of the metering valve.

4-3.4 Flushing. Provisions shall be made to flush all foam system components downstream of the concentrate shutoff valves.

4-4 Foam Concentrate Tank.

4-4.1 The foam concentrate storage tank mounted on the apparatus shall meet the same requirements as specified in Section 3-2 of this standard.

4-4.2 The piping between the foam concentrate tank and the proportioner shall be sized for the maximum solution capacity and concentration rate of the foam system.

4-4.3 The elevation of the bottom of the foam concentrate tank or container shall not be more than 6 ft (1.8 m) below the eductor.

Chapter 5 Pressurized Premix Foam Systems

5-1* General.

5-1.1 Application. This chapter relates to the discharge of premixed foam solution from a tank by means of an expellant gas such as nitrogen. These systems are normally used with AFFF solutions. If the use of other types of concentrate is contemplated, consult the foam concentrate manufacturer.

5-2 Premix Tank.

5-2.1 Design. The tank shall be of welded construction, designed, fabricated and stamped in accordance with the requirements of the *ASME Pressure Vessel Code*, Section VIII, Division 1, for the required pressure.

5-2.1.1 Construction Material. The tank shall be of corrosion resistant alloy steel or the interior surface shall have a suitable lining to prevent corrosion due to water or the premixed foam solution. All wetted connections, including wetted shutoff valves, shall be of the same material.

5-2.2 Fill Opening and Cap. The tank shall be provided with a minimum 4 in. (102 mm) inside diameter fill opening. The fill cap shall be equipped with two handles extending from opposite sides to permit hand tightening without the use of tools so that it is free from leakage while under pressure. The cap shall be equipped with a $\frac{1}{8}$ in. (3.2 mm) thick rubber gasket inserted in a machined recess. A safety vent hole shall be located in the fill cap so that it will vent tank pressure while at least $3\frac{1}{2}$ threads are still engaged.

5-2.3 Relief Valve. An approved ASME pressure relief valve, properly set, shall be furnished on the tank to prevent the pressure from exceeding 10 percent of the maximum allowable working pressure.

5-2.4 Pressure Gage. A pressure gage shall be furnished to indicate the pressure in the premix tank.

5-3 Expellant Gas (Nitrogen) Cylinders. DOT approved cylinders shall be provided for the stored nitrogen.

5-3.1 Nitrogen Supply. There shall be a sufficient number of cylinders to operate the system when the nitrogen pressure is initially 1500 psig (10.3 MPa gage) expelling the total design solution capacity and with sufficient reserve to clean out all lines.

5-3.2 Nitrogen Cylinder Storage. The cylinders shall be located for ease of access for both operation and replacement individually.

5-3.3 Nitrogen Cylinder Valves. The cylinder valves shall be in accordance with the standard of the Compressed Gas Association. They shall have a 0.965-14-INT thread on the outlet. The valves shall be of the "Quick-Opening" type and shall include the following features:

(a)* For truck mounted units, capability of being opened from the driver's compartment of the vehicle by remote/actuator.

(b) For truck or trailer mounted units, capability of being opened manually at the valve by the following means:

1. Quick-opening lever actuator or hand-wheel actuator on each nitrogen cylinder.

2. Actuator to open all nitrogen cylinders.

(c) All opening methods shall be independent and arranged such that they will not interfere with each other.

(d) Capability of being manually closed at the cylinder.

(e) Provided with an integral pressure gage.

(f) Provided with an integral safety relief.

5-3.4* Nitrogen Pressure Regulator. The number of regulators provided shall be sufficient to maintain the rated flow of all discharge devices simultaneously. Each regulator shall be designed for an inlet pressure of at least 3000 psi (20.69 MPa), and shall be set and sealed to deliver nitrogen at the required working pressure. The regulator shall be able to operate safely through a temperature range of -65°F and to $+160^{\circ}\text{F}$ (-53.9°C to $+71.1^{\circ}\text{C}$).

Each regulator or regulator manifold shall be equipped with a spring loaded pressure relief valve and shall be connected to the nitrogen cylinders through a $\frac{3}{8}$ in. (9.5 mm) minimum diameter wire braid hose.

5-4 Valving and Piping.

5-4.1 Constant Operating Pressure. The valving and piping shall be installed so that, for normal operation, the gas from the cylinder passes through the regulator, the regulator manifold and piping to maintain nominally constant pressure in the premix tank during discharge.

5-4.2 Hose Valves. The flow of foam solution from the premix tank into each hosereel shall be controlled by a quarter turn soft seated ball valve.

5-4.3 Solution Backup. Provision shall be made to prevent backup of foam solution into the nitrogen supply piping.

5-4.4 Clean Out. Valves and piping shall be designed so that, after use, the hose lines may be blown clean.

Chapter 6 Alternate Proportioning Systems for Mobile Fire Apparatus

6-1* General.

6-1.1 Application. This chapter relates to pressure proportioning and in-line inductor foam systems that may be used as alternates to the more commonly used systems covered in other chapters of this standard. Both systems utilize water pressure to proportion the foam concentrate in producing foam solution, and do not require a foam concentrate pump.

6-2 Pressure Proportioning System.

6-2.1 Description. The pressure proportioning system consists of a pressure tank for the foam concentrate and a venturi proportioner. The proportioner consists of a water inlet and a chamber that divides the water flow into two directions, one into the foam concentrate tank and the other through a venturi to a mixing chamber. The proportioner also includes a siphon tube that extends from the mixing chamber down to a point near the bottom of the tank. The venturi creates a low pressure area downstream in the mixing chamber, allowing the foam concentrate to travel up the siphon to mix with the water to form solution.

6-2.1.1 Pressure proportioning systems have the following limitations:

(a) 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.

(b) These units cannot be recharged when in use.

6-2.2 Venturi proportioners shall be of a design that will minimize pressure drop when operating at the design flows and pressures.

6-2.3 Foam Concentrate Tank. The tank shall be of welded construction, designed, fabricated and stamped in accordance with the requirements of the *ASME Pressure Vessel Code*, Section VIII, Division 1, for a minimum working pressure of 250 psig (1.7 MPa gage).

6-2.3.1 Working Pressure Rating. The rated working pressure of the tank shall be determined by the foam system requirements and the maximum water supply pressure.

6-2.3.2 Fill Connection. The foam concentrate pressure vessel shall be provided with a suitable connection for recharging the tank after use. If a fill funnel or other special equipment is required to recharge the tank, these items shall be supplied.

6-2.3.3 Inspection and Vent. The concentrate tank shall have a removable cap or plug to provide a fill vent and an inspection port.

6-2.3.4 Drain. The concentrate tank shall be fitted with a drain at the lowest point.

6-2.4 Tank Diaphragm. The concentrate tank shall be equipped with a flexible diaphragm or foam concentrate bladder to separate the foam concentrate from the pressurizing water.

6-2.4.1 Material. The diaphragm or bladder shall be made of materials that will resist corrosion, breakdown, or loss of flexibility under conditions of prolonged contact with the foam concentrate specified.

6-2.5 Shutoff Valve. A shutoff valve shall be provided in the water inlet line to the proportioner.

6-2.6 Gages. The manufacturer shall provide one gage, not less than 4½ in. (114 mm) diameter to measure inlet pressure to the pressure proportioner. This gage shall be installed downstream of the inlet control valve. This gage shall read from 0 to a value 50 psi (345 kPa) greater than the working pressure of the foam concentrate tank.

6-3 In-Line Inductor Foam Proportioning Systems.

6-3.1 Description. This section covers in-line inductor systems that are an integral part of the mobile apparatus and designed to draw from a foam concentrate supply also carried on the apparatus. Portable in-line inductor equipment is covered in NFPA 11, *Standard for Foam Extinguishing Systems*, and 11B, *Standard on Synthetic Foam and Combined Agent Systems*. In-line inductor systems produce foam solution by utilizing the pressure drop across a venturi to provide the energy necessary to siphon the foam concentrate from the supply container to the venturi where the concentrate is mixed with water. The design of the inductor determines the proportioning rate. Some inductor designs allow the operator to vary the proportioning rate within limits.

6-3.1.1 In-line inductor foam proportioning systems have the following limitations:

(a) The in-line inductor shall 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.

(b) The pressure drop across the inductor is approximately one-third of the inlet pressure.

(c) The elevation of the bottom of the concentrate container should not be more than 6 ft (1.8 m) below the inductor.

6-3.2 Foam Concentrate Tank. The foam concentrate tank shall comply with requirements applicable to atmospheric tanks as specified in Section 3-2 of this standard.

6-3.3 Pressure Loss Limit. Pressure drop across an in-line proportioner shall not exceed 40 percent of inlet pressure at the design flow rate.

6-3.4 Inductor Location. The center line of the inductor shall not be located more than 6 ft (1.8 m) above the bottom of the concentrate supply container, but shall be located above the maximum level of the concentrate supply.

6-3.5 Strainer. A strainer shall be provided between the concentrate supply and the proportioner. The strainer shall not cause a loss in suction head great enough to prevent the inductor from operating at the proper proportioning rate when the strainer is 50 percent plugged.

6-3.6 Flushing Connections. Suitable provisions shall be made to flush the proportioner and associated piping with water after use with concentrate.

6-3.7 Drains. The system shall include drain connections to permit removal of all liquids from the proportioning system after operation and flushing.

Chapter 7 Acceptance Tests and Requirements

7-1 General. Acceptance tests shall be conducted prior to delivery of the apparatus. These shall include foam system testing, pumping tests and road tests.

7-2 Foam System Tests.

7-2.1 Foam Properties. Testing of foam properties including expansion and foam drainage rate shall be performed in accordance with NFPA 11, *Standard for Foam Extinguishing Systems*, Chapter 7, or NFPA 11B, *Standard on Synthetic Foam and Combined Agent Systems*, Chapter 6, using all of the foam making accessories supplied with the apparatus.

7-2.2 Accuracy of Proportioning. The foam system shall proportion foam concentrate into water within ± 10 percent of the recommended concentration range of design flows. There are two acceptable testing methods:

(a) With the foam system in operation at a given flow, a solution sample is collected from each outlet and the concentration measured by refractometer as described in NFPA 11, *Standard for Foam Extinguishing Systems*.

(b) With the foam system in operation at a given flow using water as a substitute for foam concentrate, the water is drawn from a calibrated tank instead of foam concentrate. The volume of water drawn from the calibrated tank represents the percentage of foam concentrate used by the system.

7-2.3 Foam Making Accessories. Hose line foam making accessories and any foam making turret nozzles shall be subject to tests to insure that foam solution discharge rates and effective ranges meet specifications.

7-3 Tests of Automotive Foam Apparatus When Equipped with a Water Pump.

7-3.1 Pumping Tests. Pumping tests, including certification tests shall be performed by the manufacturer in accordance with NFPA 1901, *Standard for Automotive Fire Apparatus*, Chapter 11.

7-3.1.1 Data Required of Manufacturer. The manufacturer of the apparatus shall supply at time of delivery at least one copy of the data specified in NFPA 1901, *Standard for Automotive Fire Apparatus*, Chapter 11.

7-3.2 Design Condition Acceptance Test. An acceptance test of sufficient duration shall be performed to demonstrate satisfactory operation at design conditions without overheating of the engine, pumps or gear box and without undue vibration.

7-4 Road Tests.

7-4.1 Automotive Foam Apparatus. Road tests shall be performed by the manufacturer in accordance with NFPA 1901, *Standard for Automotive Fire Apparatus*, Chapter 11.

7-4.2 Foam Trailer. Road tests shall be performed by the manufacturer by towing the trailer on paved roads at speeds up to 50 mph (80 km/hr) to demonstrate its roadability. The trailer shall tow satisfactorily around corners and on grades up to 10 percent, and its braking ability shall be proven.