NFPA 11C

1995 Edition

Standard for Mobile Foam Apparatus

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This edition of NFPA 11C*, Standard for Mobile Foam Apparatus*, was prepared by the Technical Committee on Foam and acted on by the National Fire Protection Association, Inc. at its Annual Meeting held May 22-25, 1995 in Denver, CO. It was issued by the Standards Council on July 21, 1995, with an effective date of August 11, 1995, and supersedes all previous editions.

This edition of NFPA 11C was approved as an American National Standard on August 11, 1995.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

Origin and Development of NFPA 11C

The need for a standard concerning mobile foam apparatus was brought to the attention of the Technical Committee on Foam 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 a standard, and with the approval of the Standards Council, work on the standard was begun in 1978, and it was adopted at the 1980 Fall Meeting. The 1986 edition was a partial revision of the 1980 edition.

The 1995 edition incorporates several changes with regard to foam concentrate pumps. Editorial changes were also incorporated in an effort to make the document more user friendly.

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Committee Scope: This Committee shall have primary responsibility for documents on the installation, maintenance, and use of foam systems for fire protection, including foam hose streams.

1995 Edition

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 Chapter 8 and 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 flammable liquid spills. 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 Pumper Fire Apparatus*. The specific design and application requirements of foam for special hazard protection are defined in NFPA 11, *Standard for Low-Expansion Foam*, and NFPA 11A, *Standard for Medium- and High-Expansion Foam 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, provided 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). The liter is not part of, but is recognized by, SI and 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

For additional conversions and information, see ASTM E380, Standard for Metric Practice (*see Chapter 8*).

1-4 Definitions.

The following definitions apply to terms used in this standard. Refer to NFPA 11, *Standard for Low-Expansion Foam*; NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*; and NFPA 1901, *Standard for Pumper Fire Apparatus*, for other definitions and further explanation.

Approved.* Acceptable to the authority having jurisdiction.

Authority Having Jurisdiction.* The organization, office, or individual responsible for approving equipment, an installation, or a procedure.

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 a 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 that directs the flow of foam to the fire or flammable liquid surface.

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

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

Expellant Gas. Usually nitrogen under pressure that is used to expel a premixed foam solution from a tank through a discharge system. Carbon dioxide or dry air under pressure shall be permitted to 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 that seals 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. (*See Eductor*.)

In-line Eductor. A venturi eductor, placed in the water supply line to the foam maker to create a reduced pressure in piping that leads from a supply of concentrate so that the concentrate is automatically mixed with water in the required proportion. It is precalibrated and it can be adjustable.

Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is 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.

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 the 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 system 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 Pumper Fire Apparatus*.

(a) *Chassis Carrying Capacity.* NFPA 1901, *Standard for Pumper 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 Pumper Fire Apparatus*, shall be construed to require a mobile foam apparatus to be equipped with a water tank in addition to foam concentrate or premix solution tanks, or both.

2-1.2 Materials.

The materials used in the foam system shall be compatible with the foam concentrate or premix solution to be carried on the apparatus. Components of the system that 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.

Tanks shall be mounted in the mobile apparatus in such fashion that they can be removed and reinstalled without cutting, burning, or welding.

2-3 Nameplates and Markings.

All required permanent nameplates and markings shall be capable of withstanding the effects of extreme weather and temperature, and shall be securely attached and installed so 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, gauges, 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 $1^1/_2$ in. and larger shall conform to the American National Fire Hose Connection Screw Thread as specified in NFPA 1963, *Standard 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 that 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, gauges, and other instruments shall be grouped in one area of the apparatus designated to be the operator's position. The design of the operator's position shall be such that the operator can, without changing position, see all gauges and instruments and manipulate all controls.

2-8.1 Water Pump.

If the apparatus is equipped with a water pump, the requirements of Chapter 3 of NFPA 1901, *Standard for Pumper Fire Apparatus*, 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 can reduce foam efficiency. Foam concentrates and premix solution are subject to freezing and shall be stored under conditions that fall 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 flow range and pressure range without manual adjustments.

3-1.2 Components.

The system consists of a foam concentrate storage tank, a positive displacement type foam concentrate pump, and a 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 venturi, an orifice, and a pressure regulating system. The venturi creates a pressure drop, and the orifice is used to meter the foam concentrate at the prescribed proportioning rate. The orifice shall be permitted to be replaced with an adjustable metering valve to allow different proportioning rates. The pressure regulating system is used to obtain foam concentrate pressure equal to the water pressure. By maintaining these identical pressures at the venturi throat and the orifice (metering valve), accurate proportioning can be maintained over a wide flow range. The pressure balancing function can be maintained manually by an operator, but is more typically done automatically with a pressure regulating diaphragm valve bypass loop, or a hydraulic pressure regulated direct injection system.

3-1.4 Capacity.

Guidelines for determining the required capacity of a system, depending on the hazard to be protected, are found in NFPA 11, *Standard for Low-Expansion Foam*.

3-1.5 Truck Engine Brake Horsepower Requirement.

Where 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 and 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. gauge (2.75-mm) welded carbon steel, stainless steel, or glass reinforced plastic having equivalent structural characteristics. Stainless steel tanks can be adversely affected by certain foam concentrates and shall be protected in accordance with the foam manufacturer's recommendations. The tank shall be sized to provide at least a 20-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 shall be permitted to be used for gauging, 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 located above the normal layer of sediment that can 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 of sufficient size 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 the foam concentrate pump to be flushed with water after each use.

3-3.2 Performance.

Foam concentrate pumps shall have adequate capacities to meet the maximum system demand.To ensure positive injection of the concentrates, the discharge pressure ratings of pumps at the design discharge capacity shall be in excess of the maximum water pressure available under any condition at the point of concentration injection.

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 that come in contact with the concentrate shall not require lubrication other than the concentrate. Most petroleum-based lubricants will contaminate foam concentrate.

3-3.4.1.1 Where pumps utilizing cast or ductile iron components are used, the pumps shall be left flooded with concentrate to minimize corrosion, foaming, or sticking.

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 Device.

A preset relief device of a type that has an integral mechanical pressure adjustment shall be provided. The relief device shall be installed so that it will automatically protect the foam concentrate pump from overpressure. If a relief valve is used, it shall discharge to the pump suction.

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 Method.

The foam concentrate pump shall be driven by a power source capable of operating the foam concentrate pump under maximum design conditions.

3-3.8 Controls.

Provisions shall be made for quick and easy activation of pump operation. A visual or audible, or both, 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 pressure regulating system, 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 System. A system or device shall be provided that will automatically balance the pressure of the foam concentrate system with the water pressure. The system or device shall operate smoothly without excessive hydraulic hammer or mechanical vibration at all designed flows and pressures.

Installation shall be such that components requiring service can be removed for repair or inspection. All components shall be constructed of materials compatible with the foam concentrate to be used.

(a) Shutoff valves shall be provided on both the water and foam concentrate pressure sensing lines leading to the pressure regulating device.

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

3-4.2 Pressure Balancing Bypass.

Bypass valves and piping shall be provided, allowing the operator to shut off the flow of foam concentrate to the pressure regulating device and to manually control the proportioning system using a bypass valve.

3-4.2.1 Bypass Valve Capacity. The bypass valve shall be able to bypass the maximum capacity of the foam concentrate pump.

3-4.2.2 Bypass Valve Adjustability. The bypass valve shall be of a design that is suitable for throttling.

3-4.2.3 Bypass Valve Control Location. Control for the pressure regulating device bypass valve shall be at the operator's position so that the operator can adjust the bypass valve and see the duplex gauge 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 can 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 shall be permitted to 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. Where 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 the foam concentrate tank outlet shutoff valve and the strainer. (*See Figure A-3-1.*) It shall be designed for use with a 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 Gauge.

A duplex gauge equipped with a single scale and two needles shall be located where readily visible from the pump operator's position. The needles shall indicate water pressure and foam concentrate pressure simultaneously. Range of the duplex gauge shall be at least 300 psig (2068 kPag) but not more than 600 psig (4136 kPag); size shall be not less than $4^1/_2$ in. (114 mm) diameter.

3-6.1

Individual discharge pressure gauges required by NFPA 1901, *Standard for Pumper Fire*

Apparatus, 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 that 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 be emptied without causing 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 sources. 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 gauge pressure or on the vacuum side. An around-the-pump proportioning system 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 foam concentrate drawn into the water line is controlled by a metering valve located between the eductor and the foam concentrate storage tank.

(a) The metering valve can be manually adjusted by the operator. If the flow rate is varied, the operator shall make adjustments.

(b) The metering valve can be of a type that is manually adjusted for proportioning rate. The system automatically compensates for changing flow conditions.

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 that meets the requirements of NFPA 1901, *Standard for Pumper 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 Low-Expansion Foam*, and are 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 from 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 be no 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 discusses 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 for the required pressure in accordance with the requirements of the ASME *Pressure Vessel Code*, Section VIII, Division 1.

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 to keep it free from leakage while under pressure. The cap shall be equipped with a $^{1}/_{8}$-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 $3^{1}/_{2}$ 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 110 percent of the maximum allowable working pressure.

5-2.4 Pressure Gauge.

A pressure gauge 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.

When the nitrogen pressure is initially 1500 psig (10.3 MPa gauge), there shall be a sufficient number of cylinders to operate the system to expel the total design solution capacity while supplying 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 individual replacement.

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, the capability of being opened from the driver's compartment of the vehicle by remote actuator.

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

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

2. An 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) The capability of being manually closed at the cylinder.

(e) An integral pressure gauge shall be provided.

(f) An integral safety relief shall be provided.

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 psig (20.69 MPa gauge), 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 to +160°F (-53.9°C to +71.1°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 $^{3}/_{8}$ -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 hose reel 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 can be blown clean.

Chapter 6 Alternate Proportioning Systems for Mobile Fire Apparatus

6-1

* General.

6-1.1 Application.

This chapter discusses pressure proportioning and in-line eductor foam systems that can 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 shown on the nameplate as a function of the water flowing through the eductor. This time can vary from 2 or 3 minutes for a small unit, up to 15 minutes or longer for 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 for a minimum working pressure of 250 psig (1.7 MPa gauge) in accordance with the requirements of the

ASME *Pressure Vessel Code*, Section VIII, Division 1.

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, it 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 Gauges.

The manufacturer shall provide one gauge, not less than $4^1/_2$-in. (114-mm) diameter, to measure inlet pressure to the pressure proportioner. This gauge shall be installed downstream of the inlet control valve. This gauge shall read from 0 to a value 50 psig (345 kPa gauge) greater than the working pressure of the foam concentrate tank.

6-3 In-Line Eductor Foam Proportioning Systems.

6-3.1 Description.

This section covers in-line eductor 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 eductor equipment is covered in NFPA 11, *Standard for Low-Expansion Foam*. In-line eductor 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 eductor determines the proportioning rate. Some eductor designs allow the operator to vary the proportioning rate within limits.

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

(a) The in-line eductor 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 that run between it and the foam maker.

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

(c) The elevation of the bottom of the concentrate container should be no more than 6 ft (1.8 m) below the eductor.

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 when operating at the design flow rate.

6-3.4 Eductor Location.

The centerline of the eductor 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 eductor from operating at the proper proportioning rate when the strainer is 50 percent plugged.

6-3.6 Flushing Connections.

Suitable provisions shall be made for flushing the proportioner and associated piping with water after use with the 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 Low-Expansion Foam*, 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 shall be collected from each outlet and the concentration measured by refractometer as described in NFPA 11, *Standard for Low-Expansion Foam*.

(b) With the foam system in operation at a given flow, using water as a substitute for foam concentrate, the water shall be drawn from a calibrated tank instead of foam concentrate. The volume of water drawn from the calibrated tank indicates 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 ensure that foam solution discharge rates and effective ranges meet specifications.

7-3 Tests of Automotive Foam Apparatus Where 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 Pumper Fire Apparatus*, Chapter 9.

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 Pumper Fire Apparatus*, Chapter 9.

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 Pumper Fire Apparatus*, Chapter 9.

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.

Chapter 8 Referenced Publications

8-1

The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

8-1.1 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 11, *Standard for Low-Expansion Foam*, 1994 edition.

NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*, 1994 edition.

NFPA 1901, *Standard for Pumper Fire Apparatus*, 1991 edition.

NFPA 1963, *Standard for Fire Hose Connections*, 1993 edition.

8-1.2 Other Publications.

8-1.2.1 ASME Publication. American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.

ASME *Pressure Vessel Code*, 1992, Section VIII Division 1.

8-1.2.2 ASTM Publication. American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM E380, *Standard Practice for Use of the International System of Units*, 1993.

Appendix A Explanatory Material

This Appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

A-1-4 Approved.

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, 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 that is in a position to determine compliance with appropriate standards for the current production of listed items.

A-1-4 Authority Having Jurisdiction.

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, or 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 or her 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.

A-1-4 Listed.

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.

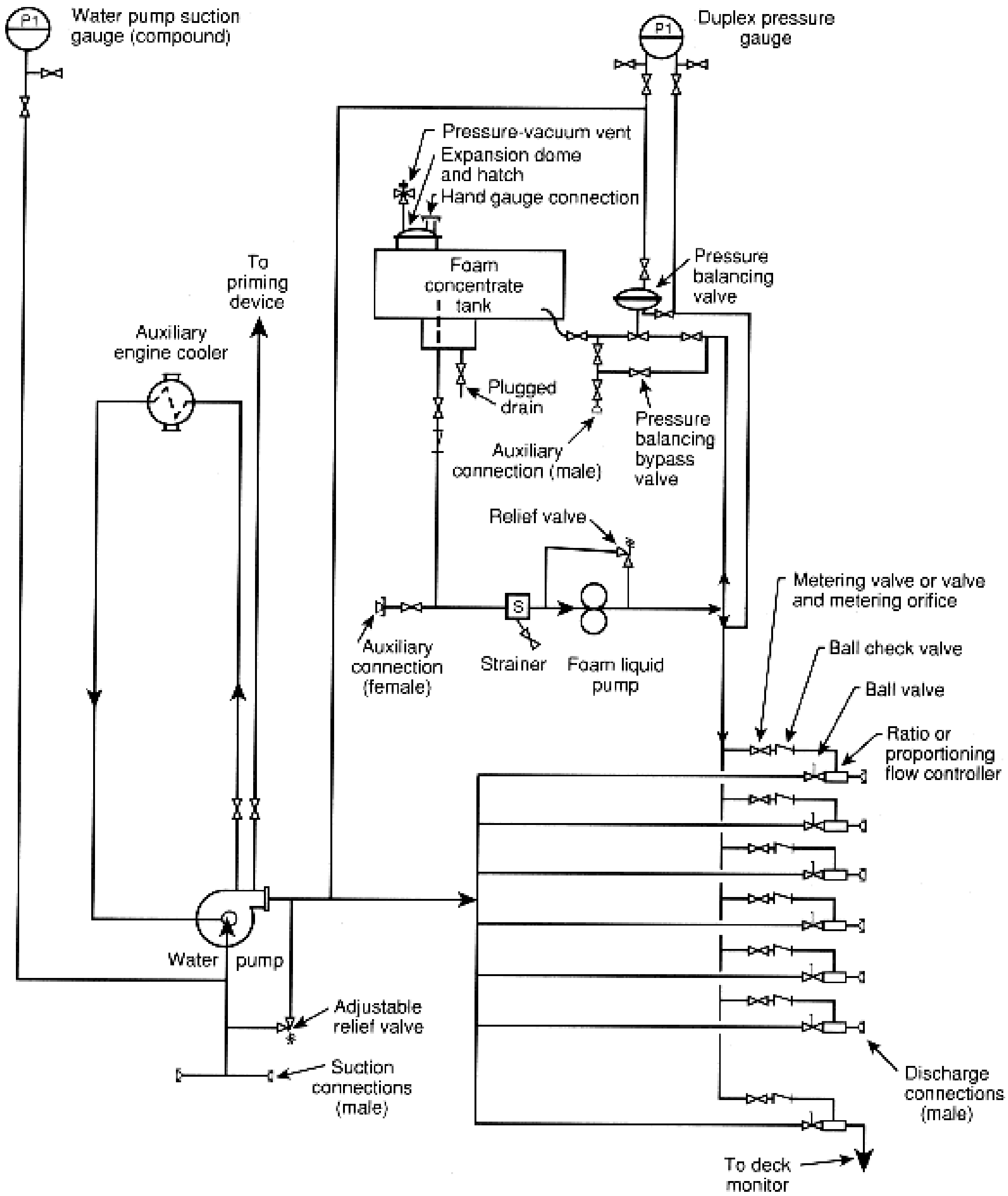

Figure A-3-1 Typical balanced pressure proportioning system.

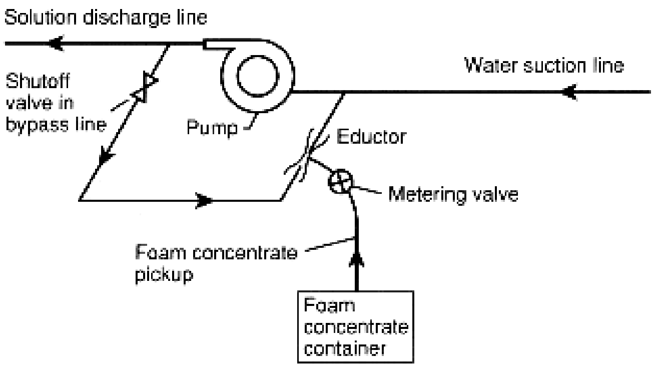

Figure A-4-1 Around-the-pump proportioning system typical arrangement.

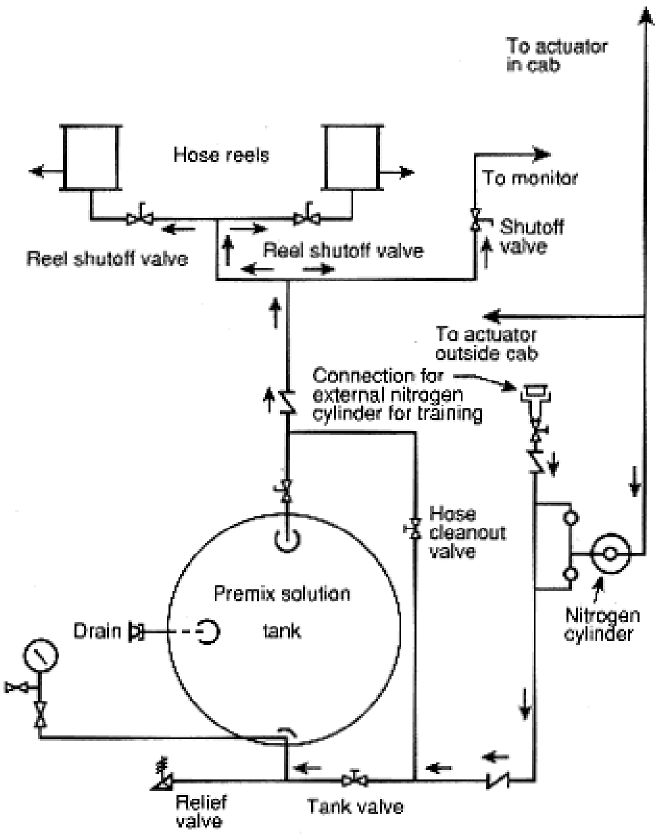

Figure A-5-1 Typical truck mounted AFFF premixed solution system.

A-5-3.3

(a) Experience has shown that a push-button pneumatic cartridge actuation is the most reliable. Cable-operated actuators are not recommended.

A-5-3.4

The preferred method is to provide a separate regulator for each nitrogen cylinder.

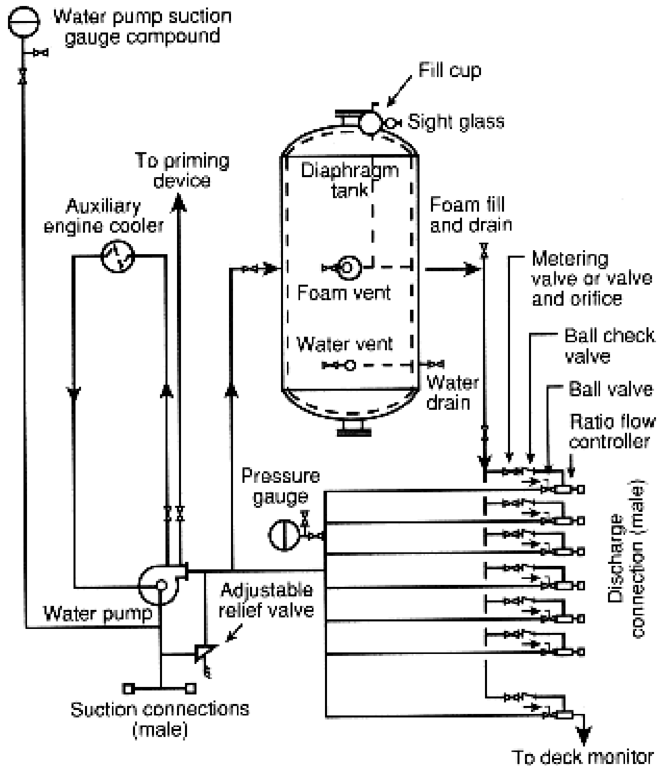

Figure A-6-1 Pressure proportioning diaphragm tank method.

Appendix B Referenced Publications

B-1

The following document or portion thereof is referenced within this standard for informational purposes only and thus are not considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

B-1.1 NFPA Publication.

National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 414, *Standard for Aircraft Rescue and Fire Fighting Vehicles*, 1995 edition.