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NFPA 1901 Pumper Fire Apparatus 1991 Edition

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The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

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NFPA 1901

Standard for

Pumper Fire Apparatus

1991 Edition

This edition of NFPA 1901, *Standard for Pumper Fire Apparatus*, was prepared by the Technical Committee on Fire Department Equipment and acted on by the National Fire Protection Association, Inc. at its Fall Meeting held November 12-14, 1990 in Miami, FL. It was issued by the Standards Council on January 11, 1991, with an effective date of February 8, 1991, and supersedes all previous editions.

The 1991 edition of this document has been approved by the American National Standards Institute.

Origin and Development of NFPA 1901

The 1991 edition of NFPA 1901 has been renamed from *Standard for Automotive Fire Apparatus* to *Standard for Pumper Fire Apparatus*. The document was totally rewritten and reorganized to include basic requirements for pumper apparatus only. NFPA 1902, *Standard for Initial Attack Fire Apparatus*; NFPA 1903, *Standard for Mobile Water Supply Fire Apparatus*; and NFPA 1904, *Standard for Aerial Ladder and Elevating Platform Fire Apparatus*, now contain the requirements for other types of apparatus previously contained in NFPA 1901.

Many new requirements were added to improve the safety of persons using this type of apparatus. These requirements include the total enclosure of all crew seating areas, maximum stepping heights on the apparatus, the provision of access handrails, and additional warning lights and reflective striping.

The minimum size fire pump was increased to 750 gpm. These pumps are required to have slow closing valves on larger intake and discharge valves, an intake relief system, interlocks to prevent the accidental movement of the apparatus during pumping operations, and better gauges.

The water tank size was increased to 500 gal minimum. Other requirements added for the water tank include sumps with cleanouts, piping vents and overflows to behind the rear axle, and provisions for quick filling and dumping of any tank over 1000 gal in capacity.

Extensive new requirements were added for auxiliary systems that may be installed on the pumper. These systems include auxiliary pumps, 120/240 volt electrical systems, foam systems, booster reels and hose, and water towers.

The test and delivery data requirements were updated to ensure that more of the performance requirements of the standard are tested as part of the delivery process and that proper documentation is provided to the purchaser.

Appendix A was greatly expanded to provide a discussion of the requirements in the standard. Appendix B contains a history of the development of fire apparatus standards. A new Appendix C provides a form that the purchaser can use to define the information needed by the contractor to properly design, build, and deliver the apparatus.

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NOTE: Membership on a Committee shall not in and of itself constitute an endorsement of the Association or any document developed by the Committee on which the member serves.

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NFPA 1901

Standard for

Pumper Fire Apparatus

1991 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 10 and Appendix D.

Chapter 1 Administration

1-1* Scope. This standard shall apply to a new automotive fire apparatus designed for sustained pumping operations during structural fire fighting and supporting associated fire department operations. It consists of a vehicle equipped with a fire pump, water tank, hose, and equipment. The vehicle may be equipped with an optional water tower to provide an elevated master stream for fire suppression tasks.

1-2 Purpose. This standard specifies the minimum requirements for a new automotive pumper fire apparatus.

1-3* Application. This standard is presented in a form that may serve as the technical section of a complete specification for purchasing pumper fire apparatus. Purchasers shall evaluate their individual needs and the intended use of the apparatus and, using this standard's basic requirements, draft a complete specification to meet the local operating conditions.

1-4 Definitions.

Acceptance. Acceptance takes place when the purchasing authority agrees with the contractor that the terms and conditions of the contract have been met.

Acceptance Tests. Tests performed on behalf of the purchaser at the time of delivery to determine compliance with the fire department's specifications.

Angle of Approach. The smallest angle made between the road surface and a line drawn from the front point of ground contact of the front tire to any projection of the apparatus in front of the front axle.

Angle of Departure. The smallest angle made between the road surface and the line drawn from the rear point of ground contact of the rear tire to any projection of the apparatus behind the rear axle.

Approved. 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."

Auxiliary Pump. A water pump mounted permanently on the fire apparatus and used either in conjunction with or independent of the fire pump for fire fighting.

Back-Up Alarm. An audible warning device designed to warn that the vehicle is in reverse gear.

Booster Pump. See Auxiliary Pump.

Chassis. The basic vehicle frame consisting of main frame rails, reinforcements, cross members, fasteners, brackets for suspension, suspension members (springs), axles, tires and wheels, cab, and power train.

Compound Gauge. A gauge reading pressure from 0 to maximum in pounds per square inch (psi) and vacuum from 0 to 30 in. of mercury (Hg) (101.6 kPa).

Contractor. The person or company responsible for fulfilling the agreed upon contract. The contractor may not necessarily manufacture the vehicle or any portion of the vehicle but is responsible for the completion, delivery, and acceptance of the entire unit.

Convenient Reach. The ability of the operator to manipulate the controls from a normal driving/riding position without excessive movement away from the seat back or without excessive loss of eye contact with the roadway.

Defect. A discontinuity in a part or a failure to function that interferes with the service or reliability for which the part was intended.

Dynamic Suction Lift. The sum of the vertical lift and the friction and entrance loss caused by the flow through the suction strainers and hose expressed in feet.

Electric Siren (Electro-Mechanical). An audible warning device that produces sound by use of an electric motor with an attached rotating slotted or perforated disc. Only one type of warning sound can be produced, but the level or pitch can be varied by the speed of the motor.

Electronic Siren. An audible warning device that produces sound electronically through the use of amplifiers and electromagnetic speakers. Varied types of warning sounds can be produced, such as wail, yelp, or simulated air horn.

Enclosed Compartments. An area confined on 6 sides with latching and closeable access opening(s) designed to provide protection to stored items from environmental damage (weather resistant).

Fire Apparatus. The emergency vehicles of the fire department or fire brigade used for fire suppression.

Fire Pump. A centrifugal water pump permanently mounted on the apparatus with a rated capacity of 750 gpm (2850 L/min) or greater at 150 psi (1035 kPa) net pump pressure, and used for fire fighting.

Fully Enclosed Personnel Area. A driving or passenger compartment of the fire apparatus providing total enclosure with positive latching doors, a roof, floor, and 4 sides.

Gallons. United States gallons.

Generator (alternator), Fixed. A mechanically driven electrical source, usually 7 kW or greater, that is permanently secured to the vehicle.

Generator (alternator), Portable. A mechanically driven electrical source, usually less than 7 kW, that can be easily removed from the vehicle and operated at a location that is remote from the vehicle. The device has an integral distribution panel with overcurrent protection and receptacle outlets.

GPM. Gallons per minute.

Gross Axle Weight Rating or "GAWR." The value specified as the load-carrying rating of a single axle system, as measured at the tire ground interfaces.

Gross Combination Weight Rating or "GCWR." The value specified as the loaded weight rating of a combination vehicle.

Gross Vehicle Weight Rating or "GVWR." The value specified by the chassis manufacturer as the loaded weight rating of a single vehicle.

Intake Relief Valve. A relief valve piped to the intake manifold of the pump and designed to automatically relieve excessive pressure from the incoming flow of water by discharging water to the environment.

Intersection Lights. Emergency flashing warning lights located as low and as far forward as practical on the side of an emergency vehicle and designed to give early warning that the emergency vehicle is entering an intersection. These lights emit maximum illumination perpendicular to the sides of the vehicle.

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.

Line Voltage Circuit, Equipment, or System. The designation used in this standard that describes 120, 120/240, or 240 volt electrical systems and their components.

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.

Low Voltage Circuit, Equipment, or System. The designation used in this standard that describes the standard 12 or 24 volt dc electrical system used to start the vehicle and to provide energy for lights, sirens, radios, and other vehicle accessories.

Manufacturer. The person or persons, company, firm, corporation, partnership, or other organization responsible for taking raw materials or components and constructing a finished product.

May. This term is used to state a permissive use or an alternative method to a specified requirement.

National Standard Hose Thread. A standard thread that has dimensions for inside and outside fire hose connection screw threads as defined by NFPA 1963, *Standard for Screw Threads and Gaskets for Fire Hose Connections.*

Net Pump Pressure.* The sum of the discharge pressure and the dynamic suction lift converted to psi when pumping at draft, or the difference between the discharge pressure and the suction pressure when pumping from a hydrant or other source of water under positive pressure.

Preconnected Line. A hose line that is always connected to an outlet on the pumper and that can be charged by the activation of one discharge valve. Also commonly called bucket line, cross lay, or mattydale.

PSI. Pounds per square inch.

PSIG. Gauge pressure in pounds per square inch (pressure above atmospheric pressure).

PTO. Power takeoff.

Pump Operator's Position. The area on a fire apparatus that contains the gauges, controls, and other instruments designed for primary control of the pump.

Pumper. A piece of fire apparatus with a permanently mounted fire pump, a water tank, and hose body that meet or exceed the requirements of this standard. The primary purpose of this type of apparatus is to combat structural and associated fires.

Purchaser. The authority having responsibility for the specification and acceptance of the apparatus.

Purchasing Authority. The agency that has the sole responsibility and authority for negotiating, placing, and, when necessary, modifying each and every solicitation, purchase order, or other award issued by a governing body.

Readily Accessible. Able to be seen, reached, and serviced or removed without removing other components or parts of the apparatus and without the need to use special tools to open enclosures.

Shall. Indicates a mandatory requirement.

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

Split Shaft PTO. A power takeoff (PTO) drive system that directs the chassis power either to the pump or to the chassis drive axle. This is accomplished by splitting the chassis driveline that connects the chassis transmission to the drive axle and inserting the split shaft PTO that has the shift mechanism necessary to direct the engine power as described above.

Sump. A recessed area of a tank assembly designed primarily to entrap sludge or debris for easy removal.

1-5 Conversion Factors. Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). The unit "liter" is outside of but recognized by SI and is commonly used in international fire protection. In this standard, values for measurement are followed by an equivalent in SI units, but only the first stated value shall be considered as the requirement, as the value in SI units may be approximate. Table 1-5 shows the actual conversion factors that can be used when SI units are not shown in the text or where more precision is desired.

Table 1-5

One gallon per minute	= 3.785 liters per minute
One gallon per minute	= .833 imperial gallons per minute
One pound per square inch	=6.895 kilopascals
One pound per square inch	=.0690 bar
One pound per square inch	=2.31 feet
One inch of mercury	= 3.386 kilopascals
One inch of mercury	= .0340 bar
One inch	= 25.40 millimeters
One foot	= .305 meters
One square inch	= 645.2 square millimeters
One mile per hour	= 1.609 kilometers per hour
One pound	= .454 kilograms
One horse power	= .746 kilowatts

Chapter 2 General Requirements

2-1* Responsibility of Purchaser. It shall be the responsibility of the purchaser to specify the details of the apparatus, its required performance, the maximum number of fire fighters to ride on the apparatus, and any hose, ground ladders, or equipment it will be required to carry that exceed the minimum requirements of this standard.

2-2 Responsibility of Contractor.

2-2.1 The bid shall be accompanied by a detailed description of the apparatus, a list of equipment to be furnished, and other construction and performance details to which the apparatus shall conform, including but not limited to, estimated weight, wheelbase, principal dimensions, transmission, and axle ratios. The purpose of these contractor specifications is to define what the contractor intends to furnish and deliver to the purchaser.

2-2.2 The contractor shall supply at time of delivery at least 2 copies of a complete operation and service manual covering the completed apparatus as delivered and accepted, including but not limited to, the chassis, pump, wiring diagrams, lubrication charts, and fire fighting equipment delivered with the apparatus.

2-2.3 Responsibility for the apparatus and equipment shall remain with the contractor until they are accepted by the purchaser.

2-2.4* A qualified and responsible representative of the contractor shall instruct personnel specified by the purchaser in the operation, care, and maintenance of the fire apparatus and equipment delivered.

2-2.5 Where special tools are manufactured or designed by the contractor and are required to provide routine service on any component of the apparatus built or supplied by the contractor, such tools shall be provided with the apparatus.

2-2.6 The apparatus shall be constructed with due consideration given to the nature and distribution of the load to be sustained and to the general character of the service to which the apparatus is to be subjected when placed in service. All parts of the apparatus shall be strong enough to withstand the general service under full load. The apparatus shall be so designed that the various parts are readily accessible for lubrication, inspection, adjustment, and repair. Minor details of construction and materials that were not otherwise specified shall be left to the discretion of the contractor, who shall be solely responsible for the design and construction of all features.

2-2.7 The apparatus shall comply with all applicable federal and state motor vehicle laws.

2-3 Vehicle Performance.

2-3.1 The apparatus shall meet the requirements of this standard at elevations up to 2000 ft (610 m) above sea level and on grades up to 6 percent.

2-3.1.1* Where the apparatus is expected to operate at elevations greater than 2000 ft (610 m) above sea level, the purchaser shall specify the maximum elevation at which performance is required. The contractor shall ensure the apparatus will perform to all requirements of this standard at the maximum specified elevation.

2-3.1.2* Where the apparatus is expected to operate on grades in excess of 6 percent, the purchaser shall specify the maximum grade at which performance is required. The contractor shall ensure the apparatus will perform to all requirements of this standard at the maximum specified grade.

2-3.2* The apparatus, when fully equipped and loaded as defined in Section 3-1, shall be capable of the following performance on dry, level [except for (d)], paved roads in good condition:

(a) From a standing start the vehicle shall attain a true speed of 35 mph (56 kmph) within 25 sec.

(b) From a steady speed of 15 mph (24 kmph) the vehicle shall accelerate to a true speed of 35 mph (56 kmph) within 30 sec. This shall be accomplished without moving gear selector.

(c)* The vehicle shall attain a minimum top speed of 50 mph (80 kmph).

(d) The apparatus shall be able to maintain a speed of at least 20 mph (32 kmph) on any grade up to and including 6 percent.

Chapter 3 Chassis and Vehicle Components

3-1* Carrying Capacity. The GAWR, and GCWR or GVWR of the chassis shall be adequate to carry the fully equipped apparatus including full water and other tanks, the specified hose load, unequipped personnel weight, ground ladders, and a miscellaneous equipment allowance of 2000 lb (908 kg). It shall be the responsibility of the purchaser to provide the contractor with the weight of equipment to be carried if it is in excess of the allowance of 2000 lb (908 kg).

3-1.1* The unequipped personnel weight shall be calculated at 200 lb (91 kg) per person times the maximum number of persons to ride the apparatus as specified in Section 2-1.

3-1.2 The contractor shall supply the final manufacturer's furnished certification of GVWR or GCWR, and GAWR on a nameplate affixed to the vehicle.

3-2 Engine and Engine System Design.

3-2.1* The propulsion or road engine supplied shall be diesel fuel or gasoline powered.

3-2.1.1* An engine governor shall be installed that will limit the speed of the engine under all conditions of operation to that speed established by the engine manufacturer; this shall be the maximum no-load governed speed.

3-2.1.2 Audible and visual warning devices, visible from the driver's position, shall be provided for high engine temperature and low oil pressure.

3-2.1.3* Automatic engine shutdown systems shall not be permitted.

3-2.1.4 The engine and transmission installation shall meet the engine and transmission manufacturer's installation recommendations for the service intended.

3-2.2 Cooling System.

3-2.2.1* The cooling system of the engine shall be adequate to maintain a temperature in the engine not in excess of the engine manufacturer's maximum temperature rating under all conditions for which the apparatus is designed. (*See also 4-2.5.*)

3-2.2.2 Where automatic radiator shutters are supplied, provisions must be made to return the shutters to the open position in the event of the failure of the automatic control. If this cannot be accomplished, manual controls shall be supplied.

3-2.2.3 Adequate and readily accessible drain valves shall be installed at the lowest point of the cooling system and at other such points as are necessary to permit complete removal of the coolant from the system. Drain valves shall be designed such that they will not open accidentally due to vibration.

3-2.2.4 The radiator shall be mounted so as to prevent the development of leaks caused by twisting or straining where the apparatus operates over uneven ground. Radiator cores shall be compatible with commercial antifreeze solutions.

3-2.3 Lubrication System.

3-2.3.1* The engine shall be provided with a replaceable element oil filter of the type approved by the engine manufacturer.

3-2.3.2 The engine oil fill pipe shall be large enough and so located to permit easy filling.

3-2.3.3 The contractor shall affix a permanent plate in the driver's compartment specifying the quantity and type of the following fluids used in the vehicle:

(a) Engine oil

(b) Engine coolant

(c) Chassis transmission fluid

(d) Pump transmission lubrication fluid

(e) Pump primer fluid, if used

(f) Drive axle lubrication fluid.

3-2.4 Fuel and Air System.

3-2.4.1* Diesel Engines.

3-2.4.1.1 A dry-type air filter shall be provided. Air inlet restrictions shall not exceed the engine manufacturer's recommendations. The air inlet shall be protected to prevent water and burning embers from entering the air intake system. The manufacturer shall provide an air restriction indicator, mounted in the cab, visible to the driver.

3-2.4.1.2* The diesel fuel system shall be of the injector type, supplied by the engine manufacturer, and shall be of sufficient size to develop the rated power. The contractor shall ensure that supply fuel lines and fuel filters are in accordance with the engine manufacturer's recommendations.

3-2.4.1.3* Where an electric fuel priming system is furnished, the valving and piping shall be arranged and labeled so that it may only be operated to reprime the fuel system. When the system is not being intentionally operated, it shall be isolated from the normal fuel system and inoperable.

3-2.4.2 Gasoline Engines.

3-2.4.2.1 A dry-type or oil bath air filter shall be provided. Air inlet restrictions shall not exceed the engine manufacturer's recommendations. The air inlet shall be protected so as to prevent the entry of water.

3-2.4.2.2 Fuel lines and filters or strainers that meet the engine manufacturer's recommendations shall be of a serviceable type and mounted in an accessible location. Where 2 or more fuel lines are installed, separate fuel pumps operating in parallel with suitable check valves and filtering devices shall be provided. The fuel line(s) shall be located or protected so as not to be subjected to excessive heating from any portion of a vehicle exhaust system. The line(s) shall be protected from mechanical damage. Suitable valves and drains shall be installed. The carburetor(s) of a gasoline engine shall be nonadjustable, with the exception of the idle setting, of sufficient size to develop the rated power, and located so as not to be subjected to pocketing of vapor or excessive heating. Where carburetors are supplied, a manual or automatic choke shall be provided. The gasoline feed system shall include an electrically operated fuel pump located within or adjacent to the fuel tank.

3-2.5* Exhaust System. The exhaust piping and discharge outlet shall be located so as not to expose any portion of the apparatus or equipment to excessive heating. Exhaust pipe discharge shall be directed away from the pump operator's position. Silencing devices shall be provided. Exhaust back pressure shall not exceed the limits specified by the engine manufacturer. Where parts of the exhaust system are exposed so that they are likely to cause injury to operating personnel, suitable protective guards shall be provided.

3-2.6 Service Accessibility. The apparatus shall be designed so that all recommended daily maintenance checks can be performed easily by the operator without the need for hand tools. Apparatus components that interfere with repair or removal of other major components must be attached with fasteners (capscrews, nuts, etc.) so that the components can be removed and installed with normal hand tools. These components must not be welded or otherwise permanently secured into place.

3-3 Apparatus Electrical System and Devices.

3-3.1 General.

3-3.1.1 Any alternator, cranking motor, ignition wiring, distributor, or ignition coil shall be moisture resistant and protected against excessive heat.

3-3.1.2 Electromagnetic interference/suppression shall be provided in accordance with SAE J551, *Performance Levels and Methods of Measurement of Electromagnetic Radiation from Vehicles and Devices (30-1000 MHZ).*

3-3.1.3* All electrical circuit feeder wiring supplied and installed by the apparatus manufacturer shall be stranded copper alloy conductors of a gauge rated to carry 125 percent of the maximum current for which the circuit is protected. Insulation shall be in accordance with SAE J1128, *Low Tension Primary Cable*, type SXL or GXL, and wired to SAE J1292, *Automobile, Truck, Truck-Tractor, Trailer and Motor Coach Wiring*, for such loading at the potential employed. Voltage drops in all wiring from the power source to the using device shall not exceed 10 percent. Overall covering of conductors shall be 280°F (143°C) minimum flame retardant, moisture resistant loom or braid. All connections shall be made with lugs or terminals mechanically secured to the conductors. Wiring shall be thoroughly secured in place and suitably protected against heat, oil, and physical damage. Wiring shall be color coded or printed with a circuit function code over each conductor's entire length.

3-3.1.4 Circuits shall be provided with properly rated low voltage overcurrent protective devices. Such devices shall be readily accessible and protected against excessive heat, physical damage and water spray. Switches, relays, terminals, and connectors shall have a direct current rating of 125 percent of maximum current for which the circuit is protected.

3-3.2 Power Supply.

3-3.2.1* A minimum of a cold rated 130 amp, 12 volt electric alternator shall be provided. It shall have an output adequate to meet the continuous anticipated electrical load of the apparatus as manufactured, at 200°F (93°C) ambient temperature (under hood), and be provided with full automatic regulation. It shall have a 60-amp minimum output at 200°F (93°C) at engine idle speed.

3-3.2.2 A voltmeter shall be provided on the instrument panel.

3-3.2.3 If a line voltage (120 and/or 240 volt) electric power generating system is provided, it shall be installed in accordance with the requirements of Section 8-2 of this standard.

3-3.3 Batteries.

3-3.3.1* Batteries shall be high cycle type. They shall be securely mounted and adequately protected against physical damage and vibration, water spray, and engine and exhaust heat. Where an enclosed battery compartment is provided, it shall be adequately ventilated to prevent the buildup of heat and explosive fumes, and the batteries shall be readily accessible for examination, test, and maintenance. If the battery is located in the engine compartment or adjacent to exhaust system components, heat shields shall be provided.

3-3.3.2 An onboard battery conditioner, or charger, or a polarized inlet shall be provided for charging all batteries. Where an onboard conditioner or charger is supplied, the associated line voltage electric power system shall be in accordance with Section 8-2 of this standard.

3-3.3.3* A master load disconnect switch shall be provided between the starter solenoid(s) and the remainder of the electrical loads, with the batteries connected directly to the starter solenoid(s). The alternator shall be wired directly to the batteries through the ammeter shunt(s), if one is provided, and not through the master load disconnect switch. A green "battery on" pilot light that is visible from the driver's position shall be provided.

3-3.3.4* The battery capacity and wiring circuits provided, including the starter switch and circuit and the starter to battery connections, shall meet or exceed the engine manufacturer's minimum recommendations. The battery system capacity shall be a minimum of 1000 cold cranking amps (CCA).

3-3.4 Starting Device. An electrical starting device shall be provided for the engine. Its characteristics shall be such that, when operating under maximum load, the voltage drop of the conductors shall be in accordance with SAE J541, *Voltage Drop for Starting Motor Circuits.*

3-3.5 Lights and Warning Devices.

3-3.5.1* Each apparatus shall have one or more rotating, oscillating, or flashing lights, visible through 360 degrees in a horizontal plane, mounted on the cab roof or as high as practical. In addition, a pair of flashing, oscillating, or rotating warning lights shall be affixed on the front of the vehicle facing forward and below the windshield level with another pair affixed at the rear of the vehicle facing to the rear. Also, an intersection light shall be affixed between the front wheel and the front of the vehicle on each side. The color of emergency lights shall be specified by the purchaser. All required warning lights must be SAE Class 1 as defined in J595, *Flashing Warning Lamps for Authorized Emergency, Maintenance, and Service Vehicles*; J845, *360 Degree Warning Lamp for Authorized Emergency, Maintenance, and Service Vehicles*; or J1318, *Gaseous Discharge Warning Lamp for Authorized Emergency, Maintenance, and Service Vehicles*, for the applicable type of light. All warning lights shall be on the current American Association of Motor Vehicle Administrators (AAMVA) list.

3-3.5.2 A master warning light switch shall be provided.

3-3.5.3* Audible warning equipment in the form of at least one automotive traffic horn and one electric or electronic siren shall be provided. The siren shall meet the requirements of SAE J1849, *Emergency Vehicle Sirens*, and shall be on the current AAMVA list. Controls for operating the siren shall be provided within convenient reach for the persons riding in both the right and left front seat positions. Other signal devices, such as an additional siren, bell, air horn(s), buzzer, or lights, may be provided.

3-3.5.4 Where furnished, air horns, electric siren(s), and electronic siren speaker(s) shall be mounted as low and as far forward on the apparatus as practical. Audible warning equipment shall not be mounted on the roof of the apparatus.

3-3.5.5 Two swivel mounted, clear, 5000 minimum candle power lights shall be provided at the rear of the apparatus for illumination of the work area behind the apparatus and the hose bed.

3-3.5.6* Apparatus shall have sufficient lights to properly illuminate the crew compartment(s), the pump operator's panel, the engine compartment, the pump compartment, each enclosed tool and equipment compartment, work areas, steps, and walkways. Switches shall be conveniently located. Lights shall be arranged to minimize accidental breakage.

3-3.5.7 A red flashing or rotating light, located in the driving compartment, shall be illuminated automatically whenever any passenger or equipment compartment door is open.

3-3.5.8 An electric or electronic back-up alarm shall be provided that meets the Type D (87 dba) requirements of SAE J994, *Alarm—Backup—Electric—Performance, Test, and Application.*

3-3.5.9 Equipment shall be mounted so that it will not obscure the rear stop, tail, and directional lights. Directional lights shall be visible from the front, sides, and rear of the vehicle. On vehicles 30 ft (10 m) in length or longer, a turn signal shall be mounted approximately midway along the apparatus at approximately running board height.

3-4 Vehicle Components.

3-4.1* Braking System.

3-4.1.1* Service and parking brakes shall be independent and separate systems. All brakes shall be readily accessible for adjustment.

3-4.1.2 The service brake application valve, when applied, shall operate all the service brakes on the vehicle or combination of vehicles.

3-4.1.3* Where air-actuated braking systems are provided, they shall include:

(a) An automatic moisture ejector.

(b) An air drier.

(c) A pressure protection valve to prevent the use of air horns or other air operated accessories when the system air pressure drops below 80 psi (552 kPa).

(d) A quick buildup section in the air reservoir system arranged so that the apparatus is able to move within 30 sec of start-up from a completely discharged air system. The quick buildup system shall provide sufficient air pressure so that the apparatus has no brake drag and is able to stop under the intended operating conditions within the 30 sec buildup time. On a chassis that cannot be equipped with a quick buildup air brake system, an onboard automatic electric compressor with an automatically ejected electric shoreline or a fire station compressed air shoreline hookup may be provided to maintain full operating air pressure while the vehicle is not running.

3-4.1.4 Parking brakes shall control the rear wheels, or all wheels, and shall be of the positive, mechanically actuated type. The parking brake system shall hold the fully loaded apparatus on at least a 20 percent grade. A lockup device to retain applied pressure on hydraulic-actuated service brake systems, or the use of the "park" position on an automatic transmission as a substitute for a separate parking brake systems are not acceptable.

3-4.1.5 Brake performance shall comply with applicable regulations, including all of the state and federal requirements for the class of vehicle that are in effect on the date of the contract. The service brakes shall be capable of bringing the fully laden apparatus to a complete stop from an initial speed of 20 mph (32 kmph) in a distance not exceeding 35 ft (10.7 m) by actual measurement on a substantially hard level surface road that is free of loose material, oil, or grease.

3-4.2 Suspension and Wheels.

3-4.2.1 Each load-bearing tire and rim of the apparatus shall not carry a weight in excess of the recommended load for the intermittent operation of truck tires of the size used, as published in the Yearbook of the Tire and Rim Association, Inc., or as recommended by the tire manufacturer, when the apparatus is loaded as indicated in Section 3-1. Compliance shall be determined by weighing the load supported by the tires on each axle, with all movable loads located as they would be with the apparatus in service.

3-4.2.2 Axle housings and any other components except wheels and tires shall clear the road surface by at least 8 in. (203 mm).

3-4.2.3* An angle of approach and an angle of departure of at least 8 degrees shall be maintained at the front and rear of the vehicle when it is normally loaded as indicated in Section 3-1.

3-4.2.4* Fenders and guards shall be braced and firmly secured. Clearance for tire chains shall be provided in accordance with SAE J683, *Tire Chain Clearance—Trucks, Buses, and Combinations of Vehicles.*

3-4.2.5 The steering mechanism shall be capable of turning the front wheels to an angle of at least 30 degrees to either the right or left for nondriving front axles and 28 degrees for driving front axles. Power or power-assisted steering shall be provided.

3-4.3* An automatic transmission shall be provided unless a manual transmission is specified by the purchaser. Where a manual transmission and clutch are provided, they shall operate smoothly under all conditions of service.

3-4.4 Fuel Tank.

3-4.4.1* The fuel tank shall hold at least 50 gal (190 L). The capacity shall be of a size that shall permit the operation of the apparatus for at least 2 hr when operating at rated pump capacity and pressure. The tank fill opening shall be conspicuously labeled for the proper fuel.

3-4.4.2* Only one fuel tank shall be furnished when the rated tank capacity is 50 gal (190 L) or less. The fuel gauge shall indicate the proportionate amount of fuel in the tank system at any time.

3-4.4.3 The tank fill piping shall be placed so it is protected from mechanical damage during the normal use of the fire apparatus, and both the tank and the fill piping shall be placed so they are not exposed to heat from the exhaust system or other source of ignition. The tank shall be placed so it is easily removable for repairs. A means for draining the tank without removing the tank shall be supplied.

3-4.5* Front and rear hooks or tow eyes shall be attached to the frame structure to permit towing (not lifting) of the apparatus without damage.

3-4.6 A heavy-duty bumper shall be provided on the front of the chassis, and the bumper mounting brackets shall be attached to the chassis frame.

3-4.7* Driving and Crew Compartment.

3-4.7.1 A fully enclosed driving compartment with seating capacity for not less than two persons shall be provided.

3-4.7.2* The maximum number of persons to ride in the apparatus shall be specified by the purchaser (*see Section 2-1*). The manufacturer shall provide a seat with an approved seat belt within a full enclosure for the total number of persons specified. An accident prevention sign that states the number of personnel the vehicle is designed to carry shall be located in an area visible to the driver.

3-4.7.3 At any seat location the maximum noise level shall be 90 dba without any warning devices in operation, as measured by the test procedure defined in Title 49 of the *Code of Federal Regulations* (CFR), paragraph 393.94 (c), except that the test will be performed with the vehicle traveling at a steady speed of 45 mph (72 kmph) on a level, hard, smooth surface road.

3-4.7.4 All interior crew and driving compartment door handles shall be designed and installed to protect against accidental or inadvertent opening.

3-4.7.5 Head height at any seat shall be at least 37 in. (940 mm) from the seat to the ceiling with the seat depressed 1 in. (25 mm). Each seating space shall have a minimum of 22 in. (560 mm) at the shoulder level. Seat cushions shall be a minimum of 18 in. (458 mm) in width and 15 in. (381 mm) from the front of the cushion to the face of the seat back. A back cushion shall be provided. The back cushion may be split to accommodate a fully recessed SCBA and bracket. Where the back cushion is split, a head rest shall be supplied.

3-4.7.6 Signs that state "Occupants must be seated and belted when apparatus is in motion" shall be provided. They shall be visible from each seated position. An accident prevention sign shall be located at the rear step area of the vehicle, if it exists. It shall warn personnel that standing on the step while the vehicle is in motion is prohibited.

3-4.7.7* Where SCBA units are mounted within the crew compartment, a positive mechanical means of holding the SCBA device in its stowed position shall be provided. The holding device shall be designed to minimize injury to crew compartment occupants in the event of a rapid deceleration or acceleration of the apparatus.

3-4.7.8 The driver's seat shall be readily adjustable by the driver. The adjustment range shall be at least 3 in. (76 mm) from front to rear.

3-4.7.9 The following instrumentation and controls shall be mounted in the driving compartment and shall be clearly identified and visible to the driver while seated. Controls and switches that are expected to be operated by the driver while the apparatus is in motion shall be within convenient reach for the driver.

(a) Speedometer

(b) Tachometer

(c) Odometer

(d) Engine hourmeter

(e) Oil pressure indicator or gauge

(f) Coolant temperature indicator or gauge

(g) Automatic transmission temperature indicator or gauge (if applicable)

(h) Voltmeter

(i) Door open indicator light

(j) Air pressure gauge(s) (if applicable)

(k) Turn signal control and indicator lights

(l) Headlight/D.O.T. light switch

(m) High beam headlight switch and indicator

(n) Fuel level gauge(s)

(o) Master ignition switch (if a key is provided it must be nonremovable from the cab interior)

(p) Heater/defroster controls

(q) Warning lights and siren switches

(r) Master electrical load switch

(s) Battery on indicator light

(t) Windshield wipers and washer.

Chapter 4 Fire Pump and Associated Equipment

4-1 Design and Performance Requirements.

4-1.1* The fire pump shall be mounted on the apparatus and have a minimum rated capacity of 750 gpm (2850 L/min). Pumps of higher capacity shall be rated as 1000, 1250, 1500, 1750, 2000, 2250, or 2500 gpm (3785, 4732, 5678, 6624, 7570, 8516, or 9463 L/min). If the pumper is equipped with a water tower, the minimum rated pump capacity shall be sufficient to provide the flow requirements of 8-5.3.1 with a maximum intake pressure of 20 psig (138 kPa). Power to drive the fire pump may be provided by the same engine used to propel the apparatus or by a separate engine.

4-1.2 Pumping System Capability.

4-1.2.1 The pump provided shall deliver the percentage of the rated capacity shown below at the pressures indicated:

100 percent of rated capacity at 150 psi (1035 kPa) net pump pressure

70 percent of rated capacity at 200 psi (1380 kPa) net pump pressure

50 percent of rated capacity at 250 psi (1725 kPa) net pump pressure.

4-1.2.2* When dry, the pump system (in both parallel and series operation where pumps are of parallel-series type) shall be capable of taking suction and discharging water in not more than 30 sec through 20 ft (6 m) of suction hose of the size and at the lift specified in Table 4-1.3.1(a) and not over 45 sec for pumps of 1500 gpm (5678 L/min) or larger capacity. An additional 15 sec shall be allowed on these times when the pump system that includes an auxiliary 4-in. (100-mm) or larger front or rear intake pipe.

4-1.2.3 The completed apparatus pumping system shall be capable of developing a vacuum of 22 in. Hg (74.5 kPa) by means of the pump priming device and sustaining this for at least 5 min with a loss not to exceed 10 in. Hg (33.9 kPa). This shall be demonstrated with all intakes capped or plugged and all discharge caps removed.

4-1.3 Pump Suction Capability.

4-1.3.1 The pump manufacturer shall certify that the fire pump is capable of pumping 100 percent rated capacity at 150 psi (1035 kPa) net pump pressure, from draft, through 20 ft (6 m) of suction hose with a strainer attached, under the following conditions.

(a) An altitude of 2000 ft (610 m) above sea level.

(b) Atmospheric pressure of 29.9 in. Hg (101.2 kPa) (corrected to sea level).

NOTE: At an altitude of 2000 ft (610 m) the actual (uncorrected) atmospheric pressure equivalent to the sea level reading of 29.9 in. Hg (101.2 kPa) is 27.8 in. Hg (94.5 kPa).

(c) Water temperature of 60°F (15.6°C).

(d) Suction hose size and lift as indicated in Table 4-1.3.1(a).

(e) Friction and entrance loss in suction hose as given in Table 4-1.3.1(b).

Table 4-1.3.1(a)

Rated Capacity gpm	Rated Capacity L/min	Suction Hose Size in.	Suction Hose Size mm	Number of Suction Lines	Maximum Lift ft	Maximum Lift m
750	2850	4½	113	1	10	3
1000	3785	5	125	1	10	3
1250	4732	6	150	1	10	3
1500	5678	6	150	1 or 2	10	3
1750	6624	6	150	2	8	2.4
2000	7570	6	150	2	6	1.8
2250	8516	6	150	2	6	1.8
2500	9463	6	150	2	6	1.8

Table 4-1.3.1(b) Friction and Entrance Loss in 20 ft (6 m) of Suction Hose, Including Strainers

Flow Rate GPM	Suction Hose Size (Inside Diameter)													
	4 in.		4½ in.		5 in.		6 in.		2 — 4½ in.		2 — 5 in.		2 — 6 in.	
	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg
750	11.4 (2.9)	9.8	8.0 (1.6)	7.1	4.7 (0.9)	4.2	1.9 (0.4)	1.7						
525	5.5 (1.5)	4.9	3.9 (0.8)	3.4	2.3 (0.5)	2.0	0.9 (0.2)	0.8						
375	2.8 (0.7)	2.5	2.0 (0.4)	1.8	1.2 (0.2)	1.1	0.5 (0.1)	0.5						
1000			14.5 (2.8)	12.5	8.4 (1.6)	7.4	3.4 (0.6)	3.0						
700			7.0 (1.4)	6.2	4.1 (0.8)	3.7	1.7 (0.3)	1.5						
500			3.6 (0.8)	3.2	2.1 (0.4)	1.9	0.9 (0.2)	0.8						
1250					13.0 (2.4)	11.5	5.2 (0.9)	4.7	5.5 (1.2)	4.9				
875					6.5 (1.2)	5.7	2.6 (0.5)	2.3	2.8 (0.7)	2.5				
625					3.3 (0.7)	2.9	1.3 (0.3)	1.1	1.4 (0.3)	1.2				
1500							7.6 (1.4)	6.7	8.0 (1.6)	7.1	4.7 (0.9)	4.2	1.9 (0.4)	1.7
1050							3.7 (0.7)	3.3	3.9 (0.8)	3.4	2.3 (0.5)	2.0	0.9 (0.3)	0.8
750							1.9 (0.4)	1.7	2.0 (0.4)	1.8	1.2 (0.2)	1.1	0.5 (0.1)	0.5
1750							10.4 (1.8)	9.3	11.0 (2.2)	9.7	6.5 (1.2)	5.7	2.6 (0.5)	2.3
1225							5.0 (0.9)	4.6	5.3 (1.1)	4.7	3.1 (0.7)	2.7	1.2 (0.3)	1.1
875							2.6 (0.5)	2.3	2.8 (0.6)	2.5	1.6 (0.3)	1.4	0.7 (0.2)	0.6
2000									14.5 (2.8)	12.5	8.4 (1.6)	7.4	3.4 (0.6)	3.0
1400									7.0 (1.4)	6.2	4.1 (0.8)	3.7	1.7 (0.3)	1.5
1000									3.6 (0.8)	3.2	2.1 (0.4)	1.9	0.9 (0.2)	0.8
2250											10.8 (2.2)	9.5	4.3 (0.8)	3.8
1575											5.3 (1.1)	4.7	2.2 (0.4)	1.9
1125											2.8 (0.5)	2.5	1.1 (0.2)	1.0
2500											13.0 (2.4)	11.5	5.2 (0.9)	4.7
1750											6.5 (1.2)	5.7	2.6 (0.5)	2.3
1250											3.3 (0.7)	2.9	1.3 (0.3)	1.1

NOTE: Figures in parentheses indicate increment to be added or subtracted for each 10 ft of hose less than or greater than 20 ft.

4-1.3.2* The pump manufacturer shall certify that the pump is capable of pumping rated capacity at 150 psi (1035 kPa) net pump pressure at any of the following special conditions when those conditions are specified by the purchaser.

(a) At an elevation above 2000 ft (610 m).

(b) At lifts higher than those listed in Table 4-1.3.1(a) or through more than 20 ft (6 m) of suction hose or both.

(c) For pumps having a rated capacity of 1500 gpm (5678 L/min) or larger, through a single suction hose only, or through two suction hoses attached to one side of the apparatus only.

4-2 Pumping Engine Requirements.

4-2.1 The apparatus manufacturer shall approve the use of the pumping engine for stationary pumping applications in fire apparatus of the type and the size being furnished.

4-2.2 The engine shall be capable of performing the pumping tests herein specified without exceeding the maximum no-load governed speed of the engine as shown on a certified brake horsepower curve of the type of engine used without accessories. This brake horsepower curve certification shall be signed by a responsible official of the engine manufacturer.

4-2.3 The engine shall demonstrate its ability to deliver rated pump capacity at 165 psi (1138 kPa) net pump pressure.

4-2.4 If a separate pumping engine is provided, it shall meet the requirements of 3-2.1.1, 3-2.1.2, 3-2.2, 3-2.3.1, and 3-2.3.2; and paragraphs 3-2.4, 3-2.5, 3-2.6, 3-3.3, and 3-3.4.

4-2.5 A supplementary heat exchanger cooling system shall be provided on the pump drive engine. Proper valving shall be installed to permit water from the discharge side of the fire pump to cool the coolant circulating through the engine cooling system without intermixing. The heat exchanger shall be adequate in size to maintain the temperature of the coolant in the pump drive engine not in excess of the engine manufacturer's temperature rating under all pumping conditions. Appropriate drain(s) shall be provided to allow draining the heat exchanger to prevent damage from freezing.

4-2.6 Where a separate engine is used to drive the pump, a pump engine amber indicator light shall be provided in the driving compartment and shall be illuminated when the pump engine ignition is energized. It shall be labeled "Pump Engine Ignition."

4-3 Construction Requirements.

4-3.1* The fire pump shall be of the centrifugal type, with stainless steel shaft(s) and bronze impeller(s).

4-3.2 The pump shall be designed and constructed to withstand a hydrostatic test of 500 psig (3450 kPag) minimum for 10 min. A certificate documenting this test shall be furnished.

4-3.3 Where an auxiliary pump is provided in combination with a fire pump and where the pumps are interconnected such that pressure from one pump may be transmitted to the other pump, suitable check valves, intake and/or discharge relief valves, pump drive gear ratios, or other automatic means shall be provided to avoid pressurizing either pump beyond its maximum rated hydrostatic pressure.

4-3.4 The entire discharge and intake piping system, valves, drain cocks and lines, intake and outlet closures, excluding the tank fill and tank to pump lines on the tank side of the valves in those lines, shall be designed for 500 psig (3450 kPag).

4-4 Pump Intake Connections.

4-4.1* Intake(s) of the same or larger size and quantity as specified in Table 4-1.3.1(a) for suction hose size and number of lines shall be provided.

4-4.1.1 The intakes specified in 4-4.1 shall have male National Standard hose threads.

4-4.1.2 If the couplings on the suction hose carried on the apparatus are of a different size or have other means of hose attachments than the intakes, suitable adapters shall be provided on each appropriate intake.

4-4.2 Intakes shall have a removable or accessible strainer provided inside each external intake.

4-4.3* At least one auxiliary gated intake shall be provided that is controllable at the pump operator's position. The valve and piping shall be of 2½ in. (65 mm) minimum size and shall be equipped with a female swivel coupling with National Standard hose threads.

4-4.3.1* Additional intakes may be provided at other locations on the vehicle. These may be of a size larger than 2½ in. (65 mm) and shall be equipped with male or female National Standard hose threads.

4-4.3.2 Where any 3-in. (76-mm) or larger intake valve is provided, except the tank to pump intake, the valve mechanism shall not permit changing the position of the flow regulating element of the valve from full close to full open, or vice versa, in less than 3 sec.

4-4.4 Each gated intake shall be equipped with a ¾-in. (19-mm) bleeder valve located in close proximity to the intake to bleed off air or water from a hose connected to the intake. The valve shall be operational without the operator having to get under the apparatus. If a siamese is attached to an intake, it shall be equipped with a ¾-in. (19-mm) bleeder valve on each inlet.

4-4.5 All intakes shall be provided with suitable closures capable of withstanding 500 psig (3450 kPag). Intakes having male threads shall be equipped with caps; intakes having female threads shall be equipped with plugs. Where

adapters for special threads or other means for hose attachment are provided on the intakes, closures shall be provided for the adapters in lieu of caps or plugs.

4-4.6 Caps and plugs for 3½-in. (89-mm) and smaller intakes shall be secured to the apparatus with suitable chains or cables.

4-5* Intake Pressure Relief System. An adjustable 2½-in. (65-mm) or larger intake pressure relief system shall be permanently installed. The system shall be designed to automatically self-restore to a nonrelieving position when excessive pressure is no longer present.

4-5.1 The minimum range of pressure adjustment shall permit control of the intake pressure relief point from 75 psig to 250 psig (515 to 1725 kPa).

4-5.2 The purchaser shall specify if the system is to be field adjustable while in operation and, if so, where the adjustment control is to be located. The apparatus manufacturer shall preset the intake relief system at 125 psi (862 kPa) unless otherwise directed by the purchaser.

4-5.3 The surplus water discharge location shall be away from the pump operator's position and terminate in a male fitting visible to the operator with National Standard hose thread. A permanent label shall be affixed near the outlet that states "Intake pressure relief outlet—Do not cap."

4-5.4* Shutoff valves or other means to disable the operation of the relief system shall not be permitted.

4-6 Tank to Pump Intake Line. The water tank shall be connected to the intake side of the pump with a valve controlled at the pump operator's position.

4-6.1* The piping and valve arrangement shall be capable of delivering water to the pump at a minimum 500 gpm (1900 L/min) flow rate. This flow shall be sustainable while pumping a minimum of 80 percent of the tank capacity.

4-6.2* An automatic means shall be provided in the tank to pump line that prevents unintentional back filling of the water tank through the line. A means shall be provided to vent the pump to the tank during operations when all outlets may be closed while the pump is operating.

4-6.3 Connections or outlets from the tank(s) to the pump shall be suitably designed to prevent air from being entrained while pumping water from the tank. If the sump is used for the pump suction connection, the design shall prevent sludge or debris in the sump from entering the pump.

4-7 Pump Discharge Outlets.

4-7.1* Two and one-half-in. (65-mm) or larger discharge outlets shall be provided to discharge the rated capacity of the pump at the following flow rates:

Outlet Size		Flow Rates	
in.	mm	gpm	L/min
2½	65	250	950
3	76	375	1420
3½	89	500	1900
4	100	625	2365
4½	113	750	2850
5	125	1000	3785

4-7.1.1 A minimum of two 2½-in. (65-mm) outlets shall be provided. Additional outlets may be larger than 2½ in. (65 mm).

4-7.1.2 All 2½-in. (65-mm) or larger outlets shall be equipped with male National Standard hose threads. Adapter couplings with special threads or other means for hose attachment may be furnished on any or all outlets.

4-7.2* Two 1½-in. (38-mm) or larger outlets supplied by at least 2-in. (51-mm) piping and valving for preconnected hose lines shall be provided at the location of the hose storage area specified in 6-2.1(b).

4-7.3 All discharge outlets, except outlets to which a hose will be preconnected, shall be equipped with suitable caps or closures capable of withstanding 500 psi (3450 kPa). Where adapters are provided on the discharge outlets, the closures shall fit on the adapters. Caps or closures for outlets 3½ in. (89 mm) and smaller shall be secured to the apparatus with suitable chains or cables.

4-7.4 All outlets shall be equipped with valves that can be opened and closed smoothly and readily at the flows shown in 4-7.1 at pump discharge pressures of 250 psig (1724 kPag). The flow regulating element of each valve shall not change its position under any condition of operation involving discharge pressures to the maximum pressure of the pump; the means to prevent a change in position shall be incorporated in the operating mechanism and may be manually or automatically controlled. Each 3-in. (76-mm) or larger discharge valve shall have an operating mechanism that will not permit changing the position of the flow regulating element of the valve from full close to full open, or vice versa, in less than 3 sec.

4-7.5 All 2½-in. (65-mm) or larger discharge outlets shall be equipped with ¾-in. (19-mm) or larger drain or bleed off valves for draining or bleeding off pressure from a hose connected to the outlet.

4-7-6 Any 2-in. (51-mm) or larger discharge outlet to which hose is to be connected and that is not in a hose storage area shall be supplied with a sweep elbow of at least 30 degrees downward.

4-7.7* All discharge lines shall have valves controllable at the pump operator's position. Secondary valves may be provided in the discharge line if required for special applications.

4-7.8* A 1-in. (25-mm) minimum tank fill line shall be provided from the pump discharge manifold to the water tank. Where the tank is greater than 1000 gal (3785 L), the

fill line shall be 2 in. (51 mm) or larger. A valve shall be provided in this line that is suitable for throttling service and controllable at the pump operator's position.

4-7.9 No discharge outlet larger than 2½ in. (65 mm) shall be located at the pump operator's panel.

4-8 Pump Drains.

4-8.1 Suitable and readily accessible drain valve(s), arranged so that either the open or closed position is clearly indicated, shall be provided to permit draining the pump and all water-carrying lines and accessories. The drain valve(s) shall be operational without the operator having to get under the apparatus.

4-9 Pump Operator's Position.

4-9.1 There shall be an area in which the pump controls, gauges, and other instruments are located. It shall be known as the pump operator's position or panel.

4-9.2 Adequate illumination shall be provided for all gauges, discharge outlets, pump intakes, and controls.

4-9.3* All required markings shall be of a type permanent in nature, capable of withstanding the effects of extremes of weather and temperature, and shall be securely attached.

4-10 Pump Controls.

4-10.1 Provisions shall be made for quickly and easily placing the pump in operation. The lever or other device shall be marked to indicate when it is correctly positioned for pumping.

4-10.1.1 When the apparatus is equipped with an automatic chassis transmission, an interlock system shall be provided to ensure that the pump drive system components are properly engaged in the pumping mode of operation so that the pumping system can be safely operated from the pump operator's position.

4-10.1.2 Where transmission retarders, engine compression brakes, or engine exhaust brakes are furnished, they shall be automatically disengaged for pumping operations.

4-10.2* Any control device used in the pumping system power train between the engine and the pump shall be equipped with a means to prevent unintentional movement of the control device from its set position.

4-10.3 A nameplate indicating the chassis transmission shift selector position to be used for pumping shall be provided in the driving compartment and located so that it can be easily read from the driver's position.

4-10.4 Where the pump is driven by a split shaft PTO, a green indicator light shall be located in the driving compartment. This indicator light shall be energized when the pump shift has been completed and shall be labeled "Pump Engaged." Where an automatic chassis transmission is provided, a second green indicator light in the driving compartment and a green indicator light located at the pump operator's position shall be provided and energized when both the pump shift has been completed and the chassis transmission is engaged in pump gear. The light in the driving compartment shall be labeled "OK to Pump." The light on the pump operator's panel shall be positioned adjacent to and preferably above the throttle control and shall be labeled "Warning: Do Not Open Throttle Unless Light Is On." The green light on the pump operator's panel may be energized when the pump is not engaged and the transmission is in the neutral position.

4-10.5 Where an automatic chassis transmission is provided and where the pump is driven by a transmission mounted (SAE) PTO, front-of-engine crankshaft PTO, or engine flywheel PTO and is used for stationary pumping with the chassis transmission in neutral, or is used for pump and roll with the chassis transmission in any forward or reverse gear, shift indicator lights shall be provided as in (a) and (b).

(a) Two green indicator lights in the driving compartment. One of the lights shall be energized when the pump drive has been engaged and shall be labeled "Pump Engaged." The second light shall be energized when both the pump drive has been engaged and the chassis transmission is in neutral and shall be labeled "OK to Pump."

(b) One green and one red indicator light on the pump operator's panel. The green light shall be energized when both the pump drive has been engaged and the chassis transmission is in neutral. The green light shall be positioned adjacent to and preferably above the throttle and shall be labeled "Warning: Do Not Open Throttle Unless Light Is On." The red light shall be energized when the chassis transmission is not in neutral, and the ignition switch is activated, and shall be located adjacent to and preferably above the throttle, and shall be labeled "Danger: Do Not Open Throttle."

4-10.6 Where a manual chassis transmission is provided and where the pump is driven by a transmission mounted (SAE) PTO, front-of-engine crankshaft PTO, or engine flywheel PTO and is used for stationary pumping, a pump engaged green indicator light shall be provided in the driving compartment, and shall be labeled "Pump Engaged."

4-10.7 With parallel-series centrifugal pumps, the control positions for parallel operation (volume) and series operation (pressure) shall be clearly indicated. The control for changing the pump from series to parallel and vice versa shall be operable at the pump operator's position.

4-10.8* A means shall be provided for controlling the discharge pressure of the pump either through an automatic relief valve or a pressure regulator that controls the speed of the pump. The device shall be capable of operation over a range of 90 to 300 psig (620 to 2070 kPag) discharge pressure and shall limit the pressure rise upon activation to a maximum of 30 psi (207 kPa). A relief valve shall be equipped with an amber light that indicates when the valve is open. A pressure regulator shall be equipped with a

green light that indicates when the regulator is activated. The means provided shall be controllable by one person in the pump operator's position.

4-10.9 A priming device shall be provided and controlled from the pump operator's position. It shall be capable of meeting the requirements of 4-1.2.2 and of developing a vacuum of 22 in. Hg (74.5 kPa) at an altitude of 2000 ft (610 m). An exhaust primer shall not be used.

4-10.10 All pump controls and devices shall be installed so as to be protected against mechanical damage or the effects of adverse weather conditions upon their operation.

4-11* Engine Controls.

4-11.1 A hand throttle that will hold its set position shall be provided to control the engine speed. It shall be located such that it can be manipulated from the pump operator's position with all instrumentation in full view.

4-11.2 Where the chassis engine drives the pump through a split shaft pump transmission and electric or electronic engine throttle controls are provided, an interlock shall prevent advancement of the engine speed unless the parking brake is engaged, and the chassis transmission is in neutral or the water pump is engaged and the chassis transmission is in gear.

4-12 Gauges and Instruments.

4-12.1 Master pump intake and pump discharge gauges shall be provided on the pump operator's panel and located close to each other with the intake gauge to the left of the pump discharge gauge. If round gauges are used, they shall be at least size 4½ per ANSI B40.1, *Gauges—Pressure Indicating Dial Type—Elastic Element*, Figure 6, and shall have a clear viewing area of not less than 4½ in. (113 mm). If digital gauges are used, the digits shall be at least ⅝ in. (16 mm) high. They shall read from 30 in. Hg (101.6 kPa) vacuum to at least 300 psi (2070 kPa) but not more than 600 psi (4140 kPa). The accuracy of the gauges shall be a minimum of Grade 1A as defined in ANSI B40.1. Gauges shall be labeled "pump intake" for intake gauge and "pump discharge" for discharge gauge.

4-12.2 A flow meter or a pressure gauge shall be provided for each discharge outlet 1½-in. (38-mm) or larger in size and shall be labeled as to the outlet to which it is connected. If round gauges are used, they shall be at least size 2½ per ANSI B40.1, *Gauges—Pressure Indicating Dial Type—Elastic Element*, Figure 6, and shall have a clear viewing area of not less than 2½ in. (65 mm). If a digital gauge is used, the digits shall be at least ⅝ in. (16 mm) high. Pressure gauges, when used, shall be connected to the outlet side of the valve. Gauges or flow meters shall be located as nearly adjacent to the related valve control as practical. The accuracy of the gauges shall be a minimum of Grade B as defined in ANSI B40.1.

4-12.3 All gauges and instruments shall be mounted and attached so they are protected from accidental damage and excessive vibration. All analog water pressure gauges shall be liquid filled, vibration dampened, and capable of continuous operation to -40°F (-40°C) without damage.

4-12.4 All instruments shall be located so that they are readily visible at the pump operator's position.

4-12.5 Connections for test gauges shall be provided at the pump operator's position. One shall be connected to the intake side of the pump, and the other shall be connected to the discharge manifold of the pump. They shall have a ¼-in. (6-mm) standard pipe thread, shall be plugged, and shall be suitably identified.

4-12.6 A weatherproof tachometer shall be installed at the pump operator's position and shall indicate the speed of the pumping engine.

4-12.7 A means shall be provided to measure the engine speed at the pump panel independent of the tachometer specified in 4-12.6. Such means shall be readily and conveniently accessible, and its use shall not require disconnecting the tachometer. If a hand counter is used, a plate indicating the ratio of the checking shaft speed to the engine speed shall be permanently attached adjacent to the checking shaft.

4-12.8 Pumping engine oil pressure and engine-coolant temperature gauges with audible and visual warnings shall be provided at the pump operator's position and shall be grouped together with the tachometer.

Chapter 5 Water Tanks

5-1 Tank Capacity.

5-1.1 A water tank or tanks with a combined rated capacity of not less than 500 gal (1900 L) shall be provided.

5-1.2 A water tank level indicator shall be provided at the pump operator's position that indicates the level or amount of water in the tank(s).

5-2 Tank Construction.

5-2.1* All water tanks shall be constructed of noncorrosive material or other materials that are protected against corrosion and deterioration.

5-2.2 All water tanks shall be constructed to be independent of the body and compartments and shall be equipped with a suitable method for lifting the tank(s) out of the body.

5-2.3 One or more cleanout sumps that extend below the bottom of the tank with a 3-in. (76-mm) or larger removable pipe plug shall be provided.

5-2.4* Any water tank shall be provided with at least one swash partition. Each water tank shall have a sufficient number of swash partitions so that the maximum dimension of any spaces in the tank, either transverse or longitudinal, shall not exceed 48 in. (1220 mm) and shall be not less than 23 in. (584 mm).

5-2.5 Swash partitions shall have suitable vents or openings at both the top and bottom to permit movement of air and water between spaces as required to meet the flow requirements as specified in 4-6.1.

5-3 Tank Connections.

5-3.1 A convenient, covered fill opening of not less than 20 sq in. (12900 mm^2) and designed to prevent spillage shall be provided and so designed to permit the insertion of a $2\frac{1}{2}$-in. (65-mm) hose with coupling. The cover shall be labeled "Water Fill." An easily removable, readily cleaned screen shall be installed in the opening.

5-3.2* Provisions shall be made for necessary overflow and venting of tanks. Vents/overflows shall have an opening of not less than 12 sq in. (7742 mm^2). The overflow outlet shall be designed so that while the vehicle is in motion, the overflow shall direct any water to behind the rear axle so as not to interfere with rear tire traction.

5-3.3* Where the tank's size or combined tank sizes are in excess of 1000 gal (3785 L), a single outlet capable of allowing water to be transferred from the tank to an external use at an average rate of 1000 gpm (3785 L/min) shall be supplied. The purchaser shall indicate the location and type of fitting desired.

5-3.4* Where the tank size or combined tank sizes are in excess of 1000 gal (3785 L) an external fill or connection directly to the tank shall be provided. This connection shall permit a minimum filling rate of 1000 gpm (3785 L/min) from sources external to the unit. This fill connection shall be provided with a removable or accessible strainer, a shut-off valve capable of being throttled, a minimum 30-degree sweep elbow positioned downward, and a closure cap or plug. The purchaser shall indicate the location and type of fitting desired.

Chapter 6 Body, Compartmentation, and Hose Storage

6-1 Body and Compartmentation.

6-1.1* A minimum of 30 cu ft (0.85 m^3) of enclosed weather resistant compartmentation shall be provided for the storage of equipment.

6-1.1.1 The compartmentation specified shall be ventilated, lighted, and have provision for drainage of moisture.

6-1.1.2 All electrical junctions or wiring within compartments shall be protected from mechanical damage by equipment stored in the compartment. All terminal strips shall have protective covers.

6-1.2 Suitably protected space or a compartment shall be provided for the installation of radio equipment. The purchaser shall specify any special needs for communication equipment or its location.

6-1.3 Attachments shall be provided for all tools, equipment, and other items that the purchaser specifies to be furnished on the apparatus. Equipment holders shall be firmly attached and designed so that equipment will remain in place under all operating conditions, but the equipment must be quickly removable for use. Where equipment other than that purchased with the vehicle is to be carried, the purchaser shall indicate, at the time of bidding, the type of equipment and any mounting requirements that the contractor is responsible for.

6-1.4 Steps, platforms, or secure ladders shall be provided so fire fighters have access to all working and storage areas of the apparatus. The maximum stepping height shall not exceed 18 in. (458 mm) with the exception of the ground to first step. All steps, platforms, or ladders shall sustain a minimum static load of 500 lb (227 kg) without deformation and shall have skid-resistant surfaces. All steps shall have a minimum area of 35 sq. in. (22582 mm^2) and be arranged to provide at least 8 in. (203 mm) of clearance between the front of the step and any obstruction. All platforms shall have a minimum depth of 8 in. (203 mm) from the front of the platform to any obstruction. All ladders shall have at least 7 in. (178 mm) of clearance between any rung and the body.

6-1.5 Access handrails shall be provided at all entrances to the driving or crew compartment and at any location where the fire fighter is expected to climb up on the apparatus for access to equipment. Exterior access handrails shall be constructed of or covered with a slip resistant, noncorrosive material. Rails shall be between 1 in. and $1\frac{5}{8}$ in. (25 mm and 41 mm) in diameter and have a minimum clearance between the rails and any surface of at least 2 in. (51 mm). All rails shall be designed and mounted to reduce the possibility of hand slippage and to avoid snagging of hose, equipment, or clothing.

6-2 Hose Stowage.

6-2.1* Hose bed area(s), compartments, or reels shall be provided to accommodate the following. These areas may or may not be contiguous.

(a) A minimum hose storage area of 55 cu ft (1.56 m^3). If a hose bed area is used, the bed shall be not less than 60 in. (1525 mm) in length and shall be provided with an adjustable divider to accommodate split hose loads.

(b) Two areas to accommodate a minimum of 200 ft (61 m) of $1\frac{3}{4}$-in. (44-mm) double jacket hose in each. If a hose bed or compartment is furnished, it shall be not less than 60 in. (1525 mm) in length.

6-2.2 The floor of the hose stowage area(s) shall be in removable sections fabricated from noncorrosive materials. The bottom shall be constructed so as to prevent the accumulation of water and allow ventilation to aid in drying of hose. The interior shall be smooth and free of all projections such as nuts, sharp angles, or brackets that might injure the hose. Reels, handrails, ladders, and equipment holders shall not obstruct the laying of hose from the stowage area.

6-3 Metal Finish.

6-3.1* All exposed ferrous metal surfaces not chrome plated or stainless steel shall be thoroughly cleaned and prepared and shall be painted to the color(s) specified by the purchaser. If nonferrous body components are furnished, the purchaser shall specify which surfaces are to be painted. The paint, including the primer, shall be applied in accordance with the paint manufacturer's recommendation.

6-3.2 A 4-in. (100-mm) minimum width reflective stripe shall be affixed to the perimeter of the vehicle. It shall be placed up to 60 in. (1525 mm) above the ground level and shall conform to *Federal Specification for Reflectivity*, LS-300, Type 1, Class 1 or 3, Reflectivity 2. At least 60 percent of the perimeter length of each side and width of the rear and at least 40 percent of the perimeter width of the front of the vehicle shall have the reflective stripe. A graphic design meeting the reflectivity requirements of this paragraph may replace all or part of the required striping if the design or combination thereof covers a minimum of the same perimeter length as required above. The amount of reflective material shall be not less than that required for a single stripe [i.e., 4 in. (100 mm) × 60 percent of vehicle length].

6-3.3 Lettering, numbering, and decorative striping shall be provided when specified by the purchaser.

Chapter 7 Equipment Carried on Pumpers

7-1 Equipment Supplied by the Contractor. The following equipment shall be supplied and mounted by the contractor unless otherwise directed by the purchaser. The contractor shall provide such brackets or compartments as are necessary to mount the equipment properly.

7-1.1* Ground Ladders. One straight ladder a minimum of 14 ft (4.3 m) in length and equipped with roof hooks and one extension ladder a minimum of 24 ft (7.3 m) in length. All ladders shall meet NFPA 1931, *Design of and Design Verification Tests for Fire Department Ground Ladders*.

7-1.2* Suction Hose. A minimum of 15 ft (4.6 m) of suction hose shall be provided. The purchaser shall specify whether hard or soft suction hose, is to be provided, the length and size of the hose, and the size of the couplings. Suction hose shall comply with the requirements of NFPA 1961, *Standard for Fire Hose*.

7-1.2.1 Where hard suction hose is provided, a suitable suction strainer and a double female swivel connection with suction hose thread on one end and local large hydrant thread on the other end shall be furnished.

7-1.2.2 Where soft suction hose is provided, it shall have long handle female couplings with the local hydrant outlet connection on one end and the pump intake connection on the other end.

7-2* Equipment Required on Pumper. Equipment on the following list shall be available on the pumper before it is placed in service. It may be supplied by the contractor, or it may be supplied by the fire department. A detailed listing of who is to furnish the items shall be supplied by the purchasing authority. Any equipment that is carried in the driving or crew compartment(s) shall be secured in brackets or suitably tied down to minimize injury to the occupants in the event of a rapid deceleration or acceleration of the apparatus.

One 6-lb (2.7-kg) flathead axe

One 6-lb (2.7-kg) pickhead axe

One 6-ft (2-m) pike pole or plaster hook

One 8-ft (2.4-m) or longer pike pole

Two portable hand lights with mounting brackets.

Two approved portable fire extinguishers with mounting brackets. The variety shall be suitable for use on Class B and C fires. The minimum sizes shall be 80 BC rating in dry chemical or 10 BC rating in CO_2. The type of portable fire extinguishers shall be specified by the purchaser.

One $2\frac{1}{2}$-gal (9.5-L) or larger water extinguisher with bracket.

One 10-ft (3-m) folding ladder and mounting brackets. The ladder shall meet NFPA 1931, *Design of and Design Verification Tests for Fire Department Ground Ladders*.

One double female swivel connection with pump intake threads on one end and one or more $2\frac{1}{2}$-in. (65-mm) female connections with National Standard hose thread on the other.

One self-contained breathing apparatus complying with NFPA 1981, *Open-Circuit Self-Contained Breathing Apparatus for Fire Fighters*, for each seating position but not less than four.

One spare SCBA cylinder for each SCBA carried.

One first aid kit, minimum 24 units, fire department assortment.

Four combination spanner wrenches with brackets.

Two hydrant wrenches.

One double-gated reducing Leader wye, sized to fit hose used in department.

Two double female adapters, sized to fit a $2\frac{1}{2}$-in. (65-mm) or larger hose.

Two double male adapters, sized to fit a $2\frac{1}{2}$-in. (65-mm) or larger hose.

1200 ft (366 m) of $2\frac{1}{2}$-in. (65-mm) or larger fire hose.

400 ft (122 m) of $1\frac{1}{2}$-in. (38-mm), $1\frac{3}{4}$-in. (44-mm), or 2-in. (51-mm) fire hose.

Two combination fog nozzles, 200 gpm (757 L/min) minimum.

Two combination fog nozzles, 95 gpm (360 L/min) minimum.

Two playpipes, each with shutoffs and 1-in. (25-mm), $1\frac{1}{8}$-in. (29-mm), and $1\frac{1}{4}$-in. (32-mm) tips.

One rubber mallet, suitable for use on suction hose connections.

Two salvage covers a minimum size of 12 ft × 14 ft (3.7 m × 4.3 m).

Two wheel chocks mounted in readily accessible locations. Wheel chocks shall meet or exceed SAE J348, *Standard for Wheel Chocks*, for the wheel diameter on which the chocks are to be used.

Where a water tower with a permanently mounted ladder is provided, 4 Class I life safety harnesses meeting the requirements of NFPA 1983, *Standard on Fire Service Life Safety Rope, Harnesses, and Hardware*.

Chapter 8 Auxiliary Systems

8-1 Auxiliary Pump. If the apparatus is equipped with an auxiliary pump, the following provisions shall apply.

8-1.1* General. The purchaser shall indicate the type of operation and performance required from the auxiliary pump.

8-1.2 Power Train Capability.

8-1.2.1* Purchaser shall indicate the type of pump drive desired.

8-1.2.2* All components in the power train from the engine to the pump shall be capable of transmitting the continuous duty power required by the pump for at least 50 min at maximum rated capacity and pressure.

8-1.2.3* When pumping rated capacity and pressure, lubricant temperatures in any power train component shall not exceed the component manufacturer's recommendation for maximum temperature.

8-1.3 Construction Requirements.

8-1.3.1* The type of auxiliary pump shall be specified by the purchaser.

8-1.3.2 The pump and piping shall be hydrostatically tested to 100 psi (690 kPa) above maximum system operating pressure, and the apparatus manufacturer shall certify the test results in writing.

8-1.4 Pump Intake Connections.

8-1.4.1* The purchaser shall indicate the number, size, and location of the pump intake connections or combination of connections desired. Each pump intake connection shall be equipped with a control valve at the operator's location and shall be of a sufficient size to permit the full rated performance specified in 8-1.1.

8-1.4.2 External intakes shall be equipped with the following:

1. National Standard hose threads.
2. A removable or accessible strainer at each external intake.
3. A bleed-off connection to eliminate air from incoming supply lines.

8-1.4.2.1 External intakes having male threads shall be equipped with caps; external intakes having female threads shall be equipped with plugs. Where adapters for special threads or other means for hose attachment are furnished, closures shall be provided for the adapters in lieu of caps or plugs.

8-1.4.2.2 Caps and plugs for 3½-in. (89-mm) and smaller external intakes shall be secured to the apparatus with suitable chains or cables.

8-1.5* Pump Discharge Connections.

8-1.5.1 Each pump discharge line shall be equipped with a control valve at the operator's location.

8-1.5.2 Any discharge outlets that are fed by lines from both the auxiliary pump and the main pump shall have check valves in both supply lines.

8-1.5.3* All discharge outlets shall be equipped with male National Standard hose threads. Adapter couplings with special threads or other means for hose attachment may be furnished on any or all outlets.

8-1.5.4 All discharge outlets, except outlets to which a hose will be preconnected, shall be equipped with suitable caps or closures capable of withstanding 500 psi (3450 kPa). Where adapters are furnished, the closures shall fit on the adapters. Caps or closures for outlets 3½ in. (89 mm) and smaller in size shall be secured to the apparatus with suitable chains or cables.

8-1.5.5 A by-pass line of not less than ¼ in. (6.3 mm) in diameter, with a control valve at the pump operator's position, or an automatic-type control, shall be installed from the discharge manifold directly to the water tank.

8-1.5.6 If a tank fill line is provided, the line shall be connected from the pump discharge manifold directly to the water tank and shall include a valve controllable at the pump operator's position.

8-1.6 Pump Operator's Position.

8-1.6.1 Adequate illumination shall be provided for all gauges and controls located at the pump operator's position for the auxiliary pump.

8-1.6.2 All required marking shall be permanent, shall be capable of withstanding the effects of extremes of weather and temperature, and shall be securely attached.

8-1.7 Pump Controls.

8-1.7.1 Provisions shall be made for quickly and easily placing the pump in operation. The lockable lever or other device shall be marked to indicate when in pumping position.

8-1.7.2 With parallel-series centrifugal pumps, the positions for parallel operation (volume) and series operation (pressure) shall be clearly indicated. The control for changing the pump from series to parallel and vice versa shall be located at the pump operator's position.

8-1.7.3 If more than one discharge outlet is provided, a relief valve or other pressure control device shall be provided and be capable of limiting the pump discharge pressure.

8-1.7.4 All pump controls and devices shall be installed so as to be protected against mechanical damage or the effects of adverse weather conditions upon their operation.

8-1.7.5 Suitable and readily accessible drain valve(s), arranged so that either the open or the closed position is clearly indicated, shall be provided to permit draining the pump and all water-carrying lines. The drain(s) shall be controlled without the operator having to get under the apparatus.

8-1.8 Engine Controls. A hand throttle, controlling the fuel supply to the engine and of a type that will hold its set position, shall be so located that it can be manipulated from the operator's position with all gauges in full view. This may be the same throttle control that is used for the main fire pump.

8-1.9 Gauges and Instruments.

8-1.9.1 All gauges and instruments shall be mounted and attached so they are protected from accidental damage and excessive vibration. All analog water pressure gauges shall be liquid filled, vibration dampened, and capable of continuous operation to -40°F (-40°C) without damage.

8-1.9.2 A master discharge gauge of at least size 3½ per ANSI B40.1, *Gauges—Pressure Indicating Dial Type—Elastic Element*, Figure 6, and with a clear viewing area of less than 3½ in. (89 mm) shall be provided at the pump operator's position. The discharge gauge shall read from zero to at least 300 psig (2070 kPag), but not less than 100 psi (690 kPa) higher than the maximum pressure that can be developed by the pump when it is operating with zero intake pressure. If the apparatus is equipped with 1½-in. (38-mm) or larger discharge outlets that can only be supplied by the auxiliary pump, these discharge outlets shall be equipped with pressure gauges or flow meters. If round gauges are used, they shall be at least size 2½ per ANSI B40.1, Figure 6, and shall have a clear viewing area of not less than 2½ in. (65 mm). If a digital gauge is used, the digits shall be at least ⅝ in. (16 mm) high. The accuracy of the master gauges shall be a minimum of Grade 1A, and the accuracy of any line gauges shall be a minimum of Grade B as defined in ANSI B40.1.

8-1.9.3 Where the pump is driven by a transmission mounted (SAE) PTO, front of engine crankshaft PTO, or flywheel PTO, the provisions of 4-10.5 and 4-10.6 shall apply.

8-1.9.4 Where the pump is driven by a chassis transmission mounted (SAE) PTO, a visible or audible warning device shall be provided at the operator's position that is actuated when the temperature of the lubricant in the chassis transmission exceeds the transmission manufacturer's recommended maximum temperature.

8-1.9.5 Where a separate engine is used to drive the pump, a pump engine ignition red indicator light shall be provided in the driving compartment and shall be labeled "Pump Engine Ignition."

8-2* Line Voltage (120 and/or 240 Volt) Electrical Systems. Where a line voltage electrical system is provided, the following shall apply.

8-2.1 National Electrical Code.® Except where superseded by the requirements of Section 8-2, all components, equipment, and installation procedures shall conform to NFPA 70, *National Electrical Code*. Where the requirements of Section 8-2 differ from NFPA 70, Section 8-2 shall apply.

8-2.2 Purchaser's Responsibilities.

8-2.2.1 General. The purchaser shall provide a list of each piece of line voltage equipment to be operated from the electrical system. For each piece of equipment, the purchaser shall provide the following information:

(a) The type of electrical current required, i.e., direct current (dc), alternating current (ac), or either ac or dc.

(b) If ac, the nominal operating voltage, the maximum amperage, and whether single phase or 3-phase. For electronic equipment and some motors, the required quality of the alternating current must also be stated, including the upper and lower limits of voltage and the allowable variation of frequency and wave form.

(c) If dc, the nominal operating voltage and the maximum operating current. For special equipment, the required quality of the direct current must also be stated, including the upper and lower limits of voltage and the amount of ripple voltage.

(d) Whether the device is to be permanently mounted on the vehicle, carried on the vehicle but removable from it, or not a part of the vehicle but only powered by the line voltage system.

(e)* The required minimum continuous output wattage of the electrical source or sources that power the system, or if more than one type of current or voltage is required, the maximum output wattage for each type of current or voltage.

8-2.2.2 Plugs, Receptacles, and Switches. The purchaser shall specify the number and location of receptacles and switches that are needed to operate the devices to be powered by the system. Subject to the requirements of 8-2.7 and 8-2.8, the purchaser shall specify the manufacturer, NEMA number and style, and if a specific plug, receptacle, or switch is desired.

8-2.2.3 Lights. When line voltage lighting is required, the purchaser shall specify:

(a) Location and quantity of lights.

(b) Wattage of each light.

(c) Type of light mounting.

(d) Type of light bulb.

8-2.2.4 Cord Reel. When a line voltage permanently mounted cord reel is required, the purchaser shall specify the following:

(a) Location.

(b) Ampere rating and voltage of the device and cord.

(c) Quantity and type of cord.

(d) Type of connector body or junction box provided at end of cord.

(e) Type of reel rewind system desired.

8-2.2.5* Source. While the selection of the power source for the line voltage system is largely determined by the type and quantity of current desired, in many cases there are alternative choices, and the purchaser shall specify a preference.

8-2.3 Electrical Safety.

8-2.3.1 Listing. The electrical equipment and material on the fire apparatus shall be listed. No ungrounded systems shall be used. All products shall be used only in the manner in which they have been tested and found suitable for the intended use.

8-2.3.2* Grounding. Grounding shall be in accordance with Section 250-6 (Portable and Vehicle Mounted Generators) of the NEC.®

An equipment grounding means shall always be provided in accordance with Section 250-91 (Grounding Conductor Material) of the NEC. Equipment grounding conductors shall be green, green with yellow stripes, or be continuous rigid metal conduit.

The grounded circuit conductor (neutral) shall be insulated from the equipment grounding conductors and from the equipment enclosures and other grounded parts. The neutral conductor shall be colored white or gray in accordance with Section 200-6 (Means of Identifying Grounding Conductors) of the NEC. The grounded circuit (neutral) terminals in the distribution panelboard and in appliances shall be insulated from the equipment enclosure. Bonding screws, straps, or buses in the distribution panelboard or on appliances between the neutral and equipment grounding conductor shall be removed and discarded.

The internal bonding of the neutral wire to the frame of the power source is provided by the manufacturer of the power source on most single phase portable generator sets. On larger generator sets it is the installer's responsibility to bond the neutral at the generator set.

All exposed, noncurrent-carrying, metal parts that may become energized shall be effectively bonded to the equipment grounding terminal or the enclosure of the distribution panelboard. A bonding conductor shall connect any distribution panelboard to an accessible terminal point on the chassis using a stranded copper conductor of the proper size.

8-2.3.3 Water Resistance. Except for devices and components mounted in the interior passenger compartment or in other weatherproof compartments, all devices and components of the line voltage electrical system shall be suitable for use in wet locations.

8-2.3.4 Maximum Voltage. The maximum voltage between any conductor and any other conductor or an earth ground shall not exceed 250 volts.

8-2.4 Power Source.

8-2.4.1 General. The power source shall be installed and vented per the manufacturer's instructions and shall be effectively bonded to the apparatus chassis. Adequate access shall be provided to permit both routine maintenance and removal for major servicing.

8-2.4.2 Gasoline or Diesel Powered Generators. Any generator, whether fixed or portable, that can be operated while mounted on the vehicle shall:

(a) Be installed so fumes, vapors, heat, excessive noise, and vibrations do not enter the interior passenger compartment.

(b) Have the exhaust outlet located so it is away from any point from which the vehicle is normally operated.

(c) Comply with Section 445 (Generators) of the NEC.

8-2.5 Distribution Panels.

8-2.5.1 Fixed Sources. All permanently mounted electrical sources shall be hardwired to a permanently mounted distribution panel. Individual circuit breakers shall be provided for each circuit and shall be sized for the intended circuit use, in accordance with Section 240-3 (Protection of Conductors) of the NEC. Individual breakers shall be easily accessible and labeled with a permanent-type nameplate indicating the circuit that they protect.

8-2.5.2 Portable Sources. Portable electrical sources may be connected to circuits and devices using the outlet receptacles with which they are supplied by their manufacturer.

8-2.6 Wiring Methods.

8-2.6.1 General. Line voltage electrical wiring systems shall be limited to the following methods:

(a) Conduit.

(b) Type SO cord [600 V, 90°C (194°F) minimum] in exposed areas, which is covered in 150°C (302°F) minimum, flame retardant, moisture resistant loom.

8-2.6.2 Conductors. Only stranded copper conductors shall be used. Conductors shall be sized in accordance with Table T310-16 (Conductor Capacity) of the NEC. Aluminum or coppered aluminum conductors shall not be used.

8-2.6.3 Boxes. Boxes shall conform to and be mounted in accordance with Article 370 (Outlet, Device, Pull and Junction Boxes, Conduit, Bodies, and Fittings) of the NEC. The maximum number of conductors permitted in the boxes shall be in accordance with Section 370-6.

8-2.6.4 Additional Protection. Where subject to physical damage, exposed cable shall be protected by guard strips, grommets, raceways, or other means.

8-2.6.5 Splices. Conductor splices and connections at terminals shall be in accordance with Section 110-14 (Electrical Connections) of the NEC.

8-2.7 Plugs and Receptacles.

8-2.7.1 General. All exterior receptacle outlets and interior receptacles used to power external devices shall be of the grounding, weatherproof type and installed in accordance with Section 210-7 (Receptacles and Cord Connectors) of the NEC.

Receptacles permanently mounted in the interior passenger compartment and used only to power devices operated in this compartment may be of the grounding, nonweatherproof type.

No receptacle shall be installed in a face-up position. Plugs and receptacles may be of locking or nonlocking design.

8-2.7.2* Mechanical Connections. When severe loads are to be applied to connector terminals, external load transfer from jacket to jacket shall be provided to avoid disconnection or placing excess strain on connector terminals.

8-2.7.3 Permissible Configurations. All single phase plugs and receptacles rated at 30 amperes or less shall be of the NEMA configuration appropriate for their intended service. (*See Table 8-2.7.3 for appropriate configurations.*) For ac voltages and amperages other than those in 8-2.7.3, the correct configuration shall be selected from NEMA standard WD 6, *Dimensional Requirements for Wiring Devices*. For dc voltages, use plugs and receptacles rated for the appropriate dc service.

Table 8-2.7.3

Single Phase AC Voltage

Amperage	Blade Type	125	125/250	250
15A	Locking Nonlocking	L5-15 5-15	None 14-15	L6-15 6-15
20A	Locking Nonlocking	L5-20 5-20	L14-20 14-20	L6-20 6-20
30A	Locking Nonlocking	L5-30 5-30	L14-30 14-30	L6-30 6-30

NOTE: The letter "R" following the configuration number indicates a receptacle while the letter "P" denotes a plug.

For example, the nonlocking 15 Amp., grounding receptacle found in most homes is configuration 5-15R and accepts a 3-prong plug in the configuration of 5-15P.

8-2.7.4 Low Voltage (12 or 24 Volt DC) Connectors. Plugs and receptacles used in the low voltage system must not mate in any fashion with the connectors incorporated in the line voltage electrical system. No plug or receptacle, of any configuration shown above or of any permissible configuration for use with line voltage systems, shall be used in the low voltage system of the vehicle. All low voltage plugs and receptacles shall be Milspec MS3112E12-3P or be cigarette lighter-type receptacles. Cigarette lighter receptacles shall be limited to a maximum of 10-ampere service.

8-2.7.5 Labeling of Receptacles. All receptacles shall be labeled with a permanent nameplate listing the voltage, type of current, phase, and ampere rating.

8-2.8 Switches.

8-2.8.1 General. All switches shall be sized to handle the intended load and, if located on the exterior of the vehicle, shall be of a weatherproof design. All switches shall be permanently labeled as to function.

8-2.8.2 If the circuit is to be controlled by a 12 or 24 volt control circuit (low voltage circuit), it shall be wired through appropriately rated relay(s) mounted in a weatherproof enclosure. All power wires shall be controlled by the relay(s). The neutral and ground conductor(s) shall not be interrupted.

8-2.8.3 Switches used to control dc voltage shall have an appropriate dc load rating.

8-3* Foam Proportioning System. If the apparatus is equipped with a foam proportioning system, it shall comply with the applicable paragraphs of Section 8-3.

8-3.1* Definitions.

Class A Foam. A low to medium expansion fire fighting foam designed specifically for use on Class A fuels (cellulose and fibrous materials). It may be used for direct attack on a fire to suppress or extinguish, or may be used to retard the spread of a fire. The expansion ratio and consistency of the foam may be varied to suit the situation through the use of a multitude of discharge devices including Compressed Air Foam Systems (CAFS), medium expansion nozzles, aspirating nozzles, and water fog nozzles. The foam blanket provides a prolonged release of penetrating foam solution to the fire or substrate over which it is applied, while at the same time insulating against, and reflecting back, radiant heat so as to retard further progress of the fire. These foams are supplied in highly concentrated form to be proportioned with water, with the typical concentration of 0.5 percent (rather than 3 percent or 6 percent as is the case with Class B foams.) Class A foams are not intended for use on Class B fuels.

Class B Foam. Fire fighting foam for Class B fuels within the scope of this standard is a low expansion (up to 20 to 1) stable aggregation of small bubbles of lower density than oil or water that shows tenacious qualities for covering horizontal surfaces. Air foam is made by mixing air into a water solution containing foam concentrate by

means of suitably designed equipment. It flows freely over a burning liquid surface and forms a stable, air-excluding continuous blanket to seal volatile combustible 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. Class B fire fighting foams retain these properties for relatively long periods of time.

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

Eductor. A device that uses the Venturi principle to introduce a proportionate quantity of foam concentrate into a water stream. The pressure at the throat is below atmospheric pressure allowing concentrate at atmospheric pressure in storage to flow into the water stream.

Expansion. The ratio of expanded foam volume to original foam solution volume before adding air. For example, 1000 gal (3790 L) of expanded foam from 100 gal (379 L) of foam solution is an expansion of 10 (1000/100 = 10).

Expellant Gas. A nonflammable gas under pressure used to expel premixed foam solution from a tank through a discharge system. Nitrogen is generally used, although carbon dioxide or dry air may be used.

Foam.* Fire fighting foam is a mixture of air, water, and foam concentrate. Foams are designated as Class A or Class B corresponding to the type of fire fuel that they are designed to suppress.

Caution: Hazardous materials foams are not designed for fire fighting purposes.

Foam Concentrate.* The liquid foaming agent used for mixing with the recommended amount of water and air to produce foam.

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

Hazardous Materials Foam. A nonfire fighting foam produced to seal vapors or change the chemical composition of some hazardous materials.

8-3.2 Types of Systems.

8-3.2.1* In-line Eductor System. An in-line eductor foam proportioning system shall meet the requirements of 8-3.3, 8-3.4, 8-3.6, and 8-3.7.

8-3.2.2* Self-Educting Master Stream Nozzle. A self-educting master stream nozzle that is mounted on the apparatus shall meet the requirements of 8-3.3, 8-3.4, 8-3.6, and 8-3.7.

8-3.2.3* Around-the-Pump System. An around-the-pump foam proportioning system shall meet the requirements of 8-3.3 through 8-3.7.

8-3.2.4* Premixed Foam System. A premixed foam system shall meet the requirements of 8-3.3 through 8-3.6, 8-3.8, and 8-3.9.

8-3.2.5* Balanced Pressure System. A balanced pressure foam proportioning system shall meet the requirements of 8-3.3 through 8-3.8 and 8-3.10.

8-3.2.6* Direct Injection System. A direct injection foam proportioning system shall meet the requirements of 8-3.3 through 8-3.7 and 8-3.10.

8-3.3 Design and Performance Requirements.

8-3.3.1 The apparatus shall be capable of supplying the power required by the foam proportioning system in addition to the requirements of the other power dependent systems installed on the apparatus.

8-3.3.2* The purchaser shall specify the type(s) of foam concentrate to be used in the apparatus foam proportioning system.

8-3.3.3 The foam proportioning system shall be designed to operate with the type(s) of foam concentrate specified by the purchaser.

8-3.3.4* The materials used in the construction of the foam proportioning system shall be in accordance with the recommendations of the foam concentrate manufacturer.

8-3.3.5 The apparatus manufacturer shall certify the design performance of the foam proportioning system as an integral part of the water delivery system. This shall include:

(a) Maximum capacity of foam solution capable of being discharged from the apparatus, given in gpm at an expressed percentage of injection rate.

Example: 1,000 gpm (3785 L/min) at the 6 percent rate.

(b) Maximum operating pressure of the foam proportioning system.

(c) Pressure drop across each individual proportioning device at the device manufacturer's maximum design flow rate.

(d) The minimum and maximum rate of foam solution discharge available at each individual outlet equipped with a foam proportioning device.

8-3.3.6 Discharge (pressure) lines in the foam proportioning system shall be designed and installed so that the velocity of the foam concentrate in the lines does not exceed 25 fps (7.6 mps) at the maximum design flow.

8-3.3.7 Suction lines in the foam proportioning system shall be designed and installed so that the velocity of the foam concentrate in the lines does not exceed 15 fps (4.6 mps) at the maximum design flow.

8-3.3.8 The pressure drop for foam proportioning devices installed on the discharge side of the pump, except in-line eductors, shall not exceed 20 psi (138 kPa), at the maximum design flow of the device, for outlets 2½ in. (65 mm) and larger.

8-3.3.9 Continuously wetted components shall be constructed of materials not adversely affected by foam concentrates. Adverse reactions with foam concentrates include corrosion, formation of harmful solids, deterioration of gaskets and seals, binding of moving parts, and the deterioration of the foam concentrate from contact with noncompatible materials.

8-3.3.10 Components that can be flushed with water after use shall be constructed of materials that are resistant to corrosion after being flushed with water and allowed to dry. These components shall also be constructed of materials resistant to deterioration by foam concentrates especially with regard to gaskets, seals, and binding of moving parts.

8-3.4 Controls.

8-3.4.1 All foam proportioning system controls shall be clearly identified. They shall be located at the pump operator's position unless otherwise specified.

8-3.4.2 Foam proportioning systems that incorporate a foam concentrate pump and tank shall include controls to allow the operator to operate from the tank or from an external source.

8-3.4.3 Foam proportioning systems that require flushing after use shall include readily accessible controls that allow the operator to flush the system completely with water according to the manufacturer's instructions.

8-3.4.4 Foam proportioning systems that incorporate automatic proportioning features shall be equipped with controls that allow the operator to isolate the automatic feature and operate the system in a manual mode.

8-3.4.5 For foam proportioning systems that incorporate foam concentrate metering valves, each metering valve provided shall be calibrated and marked to indicate the range of foam concentrate injection rate(s) available as determined by the design of the system.

8-3.5 Gauges, Flow Meters, and Indicators.

8-3.5.1 All gauges, flow meters, and indicators shall be located so they are readily visible at the pump operator's position. All gauges or flow meters shall be panel mounted in a manner to protect the gauge from physical damage and from excessive vibration.

8-3.5.2 All analog pressure gauges shall be liquid filled, vibration dampened, and capable of continuous operation to -40°F (-40°C) without damage.

8-3.5.3 All analog master pressure gauges shall be at least size 4½ per ANSI B40.1, *Gauges—Pressure Indicating Dial Type—Elastic Element*, Figure 6, and shall have a clear viewing area of not less than 4½ in. The accuracy of the gauges shall be a minimum of Grade 1A as defined in ANSI B40.1.

8-3.5.4 A duplex-type pressure gauge shall be provided for balanced pressure foam proportioning systems with a scale not less than 0 to 400 psi (0 to 2758 kPa).

8-3.5.5 An indicator shall be provided at the pump operator's panel to indicate the foam concentrate level in any atmospheric foam concentrate tank over 99 gal (375 L) capacity.

8-3.6 Nameplates and Instruction Plates.

8-3.6.1 All labels and marking shall be of a type permanent in nature, shall be capable of withstanding the effects of extremes of weather and temperature, and shall be attached in a manner that requires mechanical means to effect removal.

8-3.6.2 A nameplate that is clearly marked with the identification and function shall be provided for each control, gauge, and indicator related to the foam proportioning system.

8-3.6.3 An instruction plate shall be provided for the foam proportioning system that includes, as a minimum, a piping schematic of the system and basic operating instructions. Foam concentrate trade names shall not be substituted for foam solution percentage ratios on instruction plates.

8-3.6.4 A label shall be provided at any foam tank fill opening that reads "Foam Tank Fill."

8-3.7 Atmospheric Foam Concentrate Tank. If the foam proportioning system incorporates an atmospheric foam concentrate tank, the following shall apply.

8-3.7.1 The foam concentrate tank and associated piping shall be constructed of materials that will not be adversely affected by the foam concentrate to be stored in the tank. (*See 8-3.3.2.*)

8-3.7.2 The foam concentrate tank shall be provided with a protected fill opening that is designed to facilitate the operator filling the tank from 5-gal (19-L) foam concentrate containers. The tank opening shall be protected by a removable cover and screen. The cover shall be attached to the tank fill by mechanical means such as a threaded cap or a hinged cover with a mechanical latching device.

8-3.7.2.1 Foam concentrate tanks larger than 200 gal (757 L) shall incorporate a fill opening with an area of at least 36 sq in. (23227 mm^2).

8-3.7.2.2 Foam concentrate tanks of 200 gal (757 L) or less shall incorporate a fill opening with an area not less than 4 sq in. (2580 mm^2). Where a fill opening is less than 36 sq in. (23227 mm^2), a fill funnel with strainer shall be provided with a neck to fit the fill opening and a minimum 36 sq in. (23227 mm^2) fill cup.

8-3.7.3 If the foam concentrate tank is over 40 gal (151 L), it shall incorporate an expansion compartment or dome located so that foam concentrate will enter this compartment only after the entire main tank compartment is completely filled. The volume of this expansion compartment shall be not less than 2 percent of the total foam concentrate tank volume.

8-3.7.4 The foam concentrate tank shall be equipped with a pressure/vacuum vent that allows the tank to adjust automatically for changes in pressure or vacuum when filling or withdrawing foam concentrate from the tank. The pressure/vacuum vent shall not permit outside air to enter the tank freely except during operation or for normal changes in volume due to changes in temperature.

8-3.7.5 The foam concentrate tank shall not be equipped with an overflow pipe or any direct opening to the atmosphere that is not gasketed or provided with a check valve device.

8-3.7.6* The foam concentrate tank shall be designed and constructed to facilitate cleaning the inside of the tank as required.

8-3.7.6.1 Foam concentrate tanks larger than 200 gal (757 L) and with more than one internal compartment shall incorporate a removable top allowing access to each compartment or a removable personnel access hatch with a minimum inside diameter of 20 in. (508 mm). Tanks equipped with a personnel access hatch shall also be equipped with 20 in. (508 mm) minimum inside diameter manways through any internal baffles to allow personnel access to the entire tank interior.

8-3.7.6.2 Single compartment foam concentrate tanks shall incorporate a removable hatch or fill opening that allows personnel access to the entire interior of the tank.

8-3.7.7 The foam concentrate tank shall have a sufficient number of swash partitions so that the maximum dimension of any space in the tank, either transverse or longitudinal, shall not exceed 48 in. (1220 mm) and shall be not less than 23 in. (584 mm). The swash partitions shall have suitable vents and openings at the top and bottom to permit movement of air and foam concentrate between compartments to meet the maximum flow requirements of the foam proportioning system.

8-3.7.8 The foam concentrate tank outlet connection shall be connected to a sump located in the bottom of the tank and protected by an antiswirl baffle in systems where the foam concentrate delivery rate exceeds 5 gpm (19 L/min).

8-3.7.9 The foam concentrate tank inlet connection shall terminate within 2 in. (51 mm) of the tank bottom to prevent aerating the foam concentrate.

8-3.7.10 A minimum 1-in. (25-mm) valved drain shall be provided in the sump of any foam concentrate tank of 20 gal (76 L) or more. A minimum 1/2-in. (13-mm) valved drain shall be provided in the sump of any foam concentrate tank of less than 20 gal (76 L). The drain shall be piped to drain directly to the surface beneath the apparatus without contacting other body or chassis components.

8-3.7.11 The foam concentrate tank shall be constructed to be independent of the apparatus body and compartments.

8-3.8 Pressure Vessel Foam Concentrate or Foam Solution Tanks. If the foam proportioning system incorporates a pressure vessel foam concentrate tank, or the foam solution is contained in a pressure vessel, the following shall apply.

8-3.8.1 The tank shall be of welded construction and designed, fabricated, and stamped in accordance with the requirements of the ASME *Boiler and Pressure Vessel Code* Section VIII, Division 1, for the required pressure. All pressure tanks and associated piping shall be designed to a minimum of 1 1/2 times working pressure and shall be tested to the design pressure after installation.

8-3.8.2 The pressure vessel tank shall be protected against corrosion from the foam concentrate stored in the tank by one of the following methods:

(a) The tank shall be constructed of alloy steel that is not affected by foam concentrate.

(b) The tank shall be constructed with an internal coating that is not affected by foam concentrate.

(c) The tank shall be equipped with an internal diaphragm or bladder that is constructed of materials that will resist attack, breakdown, or loss of flexibility under conditions of prolonged contact with foam concentrate.

8-3.8.3 The tank shall be provided with a minimum 2-in. (51-mm) inside diameter fill opening.

8-3.8.3.1 The fill cap shall be equipped with nontapered threads and a compressible gasket.

8-3.8.3.2 Special wrenches or tools required to tighten the fill cap shall be supplied by the manufacturer and securely mounted adjacent to the fill cap.

8-3.8.3.3 A safety vent hole shall be located in the fill cap so that it will vent the tank pressure while at least 3 1/2 threads are still engaged.

8-3.8.4 A minimum 1-in. (25-mm) valved vent shall be provided on all pressure vessel tanks.

8-3.8.5 An approved ASME relief valve, properly set, shall be furnished on the tank to prevent tank pressure from exceeding 110 percent of the maximum allowable working pressure.

8-3.8.6 A minimum 1-in. (25-mm) valved drain connection shall be provided on all pressure vessel tanks.

8-3.8.7 A gauge indicating the internal pressure of the pressure vessel shall be provided and located at the operator's position.

8-3.9 Expellant Gas. If the foam system uses pressurized gas to expel the foam solution, the following requirements shall apply.

8-3.9.1 Cylinders shall be manufactured to DOT requirements as defined in Title 49 of the *Code of Federal Regulations*, Section 178C and shall be equipped with a pressure relief device meeting the requirements of S-1.1, *Pressure Relief Devices for Cylinders for Compressed Gases*, of the Compressed Gas Association.

8-3.9.2 A sufficient capacity shall be provided to discharge the entire premix charge from the tank and to clean out all lines after use.

8-3.9.3 Cylinders shall be securely mounted on the apparatus so that they will not shift during normal apparatus driving and operation. Cylinder mounting shall also include provisions to remove the cylinders easily on an individual basis from the apparatus for recharging.

8-3.9.4 Each cylinder shall be equipped with a pressure gauge and shutoff valve. A method to quickly open the cylinders and activate the system shall be provided.

8-3.9.5 A regulator(s) shall be provided between the cylinders and the tank to reduce the cylinder pressure to the pressure vessel working pressure. The regulator(s) shall be of sufficient size to maintain the rated flow of all discharge devices simultaneously. Each regulator shall be designed for an inlet pressure of at least 3000 lb (1362 kg) and shall be set and sealed to deliver the compressed gas at the required working pressure. The regulator(s) shall be able to operate safely through a temperature range of -65°F to +160°F (-54°C to 71°C).

8-3.9.6 Each regulator or regulator manifold shall be equipped with a spring loaded pressure relief valve.

8-3.9.7 System piping, subject to the specified system working pressure, shall be rated at 2 times the specified system working pressure.

8-3.10* Foam Concentrate Pump. If the foam proportioning system incorporates a foam concentrate pump, the following shall apply.

8-3.10.1 The foam concentrate pump shall operate at a design speed that prevents cavitation and foaming in the concentrate system when delivering maximum design flow.

8-3.10.2 Drive train components required to transmit power to the foam concentrate pump shall be capable of transmitting the power required by the pump under the maximum design condition.

8-3.10.3 The foam concentrate pump shall deliver the flow and pressure required when the system is operating at maximum capacity with a reserve capacity of 10 percent.

8-3.10.4 A relief valve or other over-pressure limit device shall be provided in the foam proportioning system to protect the foam concentrate pump.

8-3.10.5 One removable strainer shall be installed on the intake side of the foam concentrate pump so that any foam concentrate entering the system must pass through the strainer.

8-3.10.6 If the foam concentrate pump is used with a pressure balance system, a minimum of one 2½-in. (65-mm) external gated intake connection for foam concentrate shall be provided. A 2-in. (51-mm) pickup device with 2½-in. (65-mm) adapter shall be provided to supply the system from drums or pails through the external intake connection.

8-3.10.7 If the foam concentrate pump is used with a pressure balance system, a minimum of one 1½-in. (38-mm) external gated foam concentrate pump discharge connection shall be provided.

8-4 Booster Reel. If the apparatus is equipped with a booster reel, the following provisions shall apply:

8-4.1* A booster hose reel, together with all necessary piping and hose connections, shall be provided. Booster hose reels shall have a capacity of not less than 150 ft (46 m) of 1-in. (25-mm) booster hose and have power rewind capability.

8-4.2 The piping between the pump and the booster reel shall be a minimum size of 1½ in. (38 mm) and shall be equipped with a shutoff valve controllable at the pump operator's position.

8-4.3 One hundred fifty feet (46 m) of 1-in. (25-mm) I.D. hose and a 1-in. (25-mm) shutoff variable gallonage, 100 psi (690 kPa) nozzle shall be furnished. The booster hose shall comply with the requirements of ANSI/UL 92, *Standard for Fire Extinguisher and Booster Hose.*

8-5 Water Tower. If the apparatus is equipped with a water tower, the following provisions shall apply.

8-5.1 Definitions.

Articulating Boom. An aerial device consisting of two or more folding boom sections whose extension and retraction modes are accomplished by adjusting the angle of knuckle joints.

Auxiliary Hydraulic Power. A small gasoline engine, diesel engine, or electric motor driven hydraulic pump used to operate an aerial device in an emergency or in lieu of the main hydraulic system.

Base Section. The first or bottom section of an aerial device.

Boom. An assembled section of a water tower. The boom construction can be of either the stressed skin box beam or the trussed lattice type.

Boom Support. A structural component that is attached to the chassis frame and is used to support the aerial device when it is in the cradled position.

Burst Pressure. The pressure measured in psi or pascal, at which a hydraulic component fails due to stresses induced as a result of the pressure.

Cable. A wire rope used to transmit forces from one component to another for the purpose of extending or retracting an aerial device.

Continuous Egress. A continuous exit or rescue path down an aerial device from an elevated position to the ground.

Dead Load. The weight of the water tower structure and all materials, components, mechanisms, or equipment permanently fastened thereto.

Fly Section. Any section of an aerial telescoping device beyond the base section.

Instability. A condition of a mobile unit in which the sum of the moments tending to overturn the unit exceeds the sum of the moments tending to resist overturning.

Interlock. A device or arrangement by means of which the functioning of one part is controlled by the functioning of another.

Knuckle. A point of connection between upper and lower booms of an articulating device; the point at which lower and upper booms are hinged together.

Ladder Section. A structural member normally of an open "U" truss-type design that includes the rungs and comprises the base or fly section of an aerial ladder.

Live Load. Forces acting on the water tower from personnel, portable equipment, water, and nozzle reaction.

Load Limit Indicator. A load indicator or an instruction plate visible at the operator's position that shows the recommended safe load at any condition of aerial device elevation and extension.

Nozzle Reaction. Force that occurs when a water stream is discharged from the nozzle. The force of reaction is a function of the nozzle size and the nozzle pressure. The formula for calculating the reaction force is $F = 1.5D^2 P$, where F is the reaction force in lb, P is the discharge pressure in psi at the nozzle, and D is the diameter of the nozzle in inches.

Override. The takeover of all aerial device movement control functions by an operator at a second control station.

Rated Capacity. The weight of personnel and their personal protective equipment that can be supported at the outermost rung of an aerial ladder at full extension.

Stabilizer. A device that is used to prevent the water tower from turning over.

Stabilizer Pad. A heavy metal or wood plate inserted beneath a stabilizer shoe to give greater surface bearing area.

Stabilizer Shoe. A permanently mounted shoe on a stabilizer to provide a ground surface area.

Turntable. A rotating structural component that allows rotation of an aerial device through a rotating bearing and that connects the aerial device to the chassis and stabilization system. It is normally designed to permit continuous 360-degree rotation and may or may not contain an operator's control station.

Turntable Alignment Indicator. An indicator that facilitates alignment of the water tower with the boom support for bedding purposes.

Ultimate Strength. The ultimate strength of a material in tension, compression, or shear, respectively is the maximum tensile, compressive, or shear stress that the material can sustain, calculated on the basis of the ultimate load and the original or unrestrained dimensions.

Water Tower. A device consisting of permanently mounted power operated booms and a waterway designed to supply a large capacity mobile elevated water stream. The booms may be of articulating design or telescoping design and may be equipped with a ladder.

Yield Strength. The stress at which a material exhibits a specified permanent deformation or set.

8-5.2 General Requirements.

8-5.2.1 The water tower shall consist of 2 or more booms designed to telescope, articulate, or both and a waterway designed to supply a large capacity elevated water stream.

8-5.2.2 The rated vertical height of the water tower assembly shall be measured in a vertical plane from the discharge end of the nozzle to the ground, with the nozzle raised to its position of maximum elevation.

8-5.2.3 The rated horizontal reach of the water tower shall be measured in a horizontal plane from the center line of the turntable rotation to the end of the nozzle with the water tower extended to its maximum horizontal reach.

8-5.2.4 Height and reach dimensions shall be taken with the water tower mounted on a chassis meeting the water tower manufacturer's minimum recommended vehicle specifications, the vehicle on level ground, and stabilizers deployed per manufacturer's instructions.

8-5.2.5 The water tower may be furnished with a ladder attached to the boom or sections for continuous egress. If a ladder is supplied it shall meet the requirements of 8-5.2.5.1 through 8-5.2.5.7.

8-5.2.5.1 The ladder rungs shall be spaced on 14-in. (356-mm) centers and shall have a skid-resistant surface or covering. When covering is provided, it shall be attached in such a manner as to be secure from twisting and shall cover at least 60 percent of the length of each rung. When round rungs are furnished, the rungs shall have a minimum outside diameter of 1¼ in. (32 mm) including the skid-resistant surface or covering. When rungs other than

round are furnished, they shall have a cross-sectional area not less than 1.2 sq in. (775 mm^2), a maximum outside dimensions of the cross-sectional area (height or width) of 3.2 in. (81 mm) including the skid-resistant surface or covering, and have a minimum outside dimension of 3/4 in. (19 mm) including the skid-resistant surface or covering. The minimum design load per rung shall be 500 lb (227 kg) distributed over a 3 1/2-in. (89-mm) wide area at the center of the length of the rung with the rung oriented in its weakest position.

8-5.2.5.2 There shall be a minimum of 18-in. (457-mm) width inside the ladder between the rails measured at the narrowest point, excluding any mounted equipment.

8-5.2.5.3 Top rails shall be provided on the ladder, shall have a minimum width of 1 in. (25 mm), and shall be at a minimum height of 12 in. (305 mm) above the center line of the rungs.

8-5.2.5.4 Where a solid obstruction below the ladder is wider than 8 in. (203 mm), a minimum clearance of 7 in. (178 mm) between the center line of the rung and the obstruction shall be provided. Where the solid obstruction below the center line of the ladder is 8 in. (203 mm) or less in width, the standoff between the center line of the rung and the obstruction may be less than 7 in. (178 mm), provided there is at least 6 in. (152 mm) of rung width and 7 in. (178 mm) of depth below the center line of the rung on each side of the obstruction.

8-5.2.5.5 The apparatus shall be equipped with skid-resistant steps or rungs that provide a path at any degree of elevation from the bottom rung of the ladder to the ground. Steps or rungs, with the exception of the ground to the first step, shall be spaced on no more than 18-in. (457-mm) centers. Handrails shall also be provided within convenient reach at each step location.

8-5.2.5.6 Two folding steps with skid-resistant surfaces shall be provided on the ladder for use by the operator using the nozzle control at the tip. Each folding step shall have a minimum design load of 500 lb (227 kg) and shall be a minimum of 35 sq in. (22582 mm^2) in area. A single step that has a minimum design load of 500 lb (227 kg) and a minimum area of 100 sq in. (64516 mm^2) may be used in place of the 2 steps.

8-5.2.5.7 Provisions shall be made so that the personnel working on the ladder can attach fall protection harnesses.

8-5.3 Capacity Ratings.

8-5.3.1 The water tower shall be capable of delivering a minimum water stream of 1000 gpm at 100 psi (3785 L/min at 690 kPa) from the tower nozzle with the booms or sections and nozzle positioned in any configuration allowed by the manufacturer.

8-5.3.2 If the water tower is rated in multiple configurations, the manufacturer shall clearly describe these configurations, including the rated load capacity of each, in the operations manual and on the sign at the operator's control station.

8-5.3.3 The water tower, with stabilizers set if required, shall be capable of being raised from the bedded position to maximum elevation and extension and rotated 90 degrees in not over 105 sec. Two or more of these functions may be performed simultaneously.

8-5.3.4 If the water tower is furnished with a ladder, 8-5.3.4.1 through 8-5.3.4.3 shall apply.

8-5.3.4.1 The rated capacity of the water tower shall be a minimum load of 250 lb (114 kg) carried at the tip of the outermost fly section with the water tower placed in the horizontal position at maximum extension. The water tower shall be capable of operating in any position while carrying its rated capacity at the tip of the outermost fly section. The 250-lb (114-kg) load capacity shall be determined without water in the system.

8-5.3.4.2 The water tower shall have a rated capacity of 250 lb (114 kg) minimum, with the water tower at full extension, 45 degrees of elevation, and discharging 1000 gpm (3785 L/min) of water throughout the full range of motion of the monitor as allowed by the manufacturer.

8-5.3.4.3 All capacity ratings shall be stated in increments of 250 lb (114 kg) and shall be designated in addition to any fire fighting equipment installed on the water tower by the manufacturer.

8-5.4 Operating Mechanisms.

8-5.4.1 Power operated elevating and extending devices shall be provided. They shall be so designed and provided with adequate power to allow multiple movements of the water tower booms or sections simultaneously under all rated conditions of loading. When hydraulic components are utilized, they shall meet the requirements of 8-5.8. An automatic locking device(s) shall be provided so that the desired elevated position can be maintained. Provisions shall be made to prevent damage at top and bottom limits.

8-5.4.1.1 A lock shall be provided that will retain the water tower booms or sections in the bed when the vehicle is in motion.

8-5.4.2 A power operated turntable shall be provided that shall permit continuous rotation in either direction under all the rated conditions of loading. The turntable rotation bearing shall be accessible for lubrication and retorquing of bolts.

8-5.4.2.1 The turntable rotation mechanism shall be provided with an automatically applied brake or self-locking drive. It shall provide braking capacity with all power systems nonfunctioning to prevent turntable rotation under all rated conditions of loading.

8-5.5 Stabilization.

8-5.5.1* The following stability requirements shall be met by the water tower apparatus when it is in a service ready condition, but with all normally removable items such as

water, hose, ground ladders, loose equipment, etc., removed. Items mounted on the water tower or ladder by the manufacturer shall remain mounted.

8-5.5.1.1 The water tower shall be capable of sustaining a static load 1 1/2 times its rated capacity in every position in which the water tower can be placed when the vehicle is on a firm and level surface. If having stabilizers extended to a firm footing is part of the definition of the configuration, they shall be extended for the purpose of determining whether the vehicle meets this stability requirement.

8-5.5.1.2 The water tower shall be capable of sustaining a static load 1 1/3 times its rated capacity in every position in which the water tower can be placed when the vehicle is on a slope of 5 degrees downward in the direction most likely to cause overturning. If having the stabilizers extended to a firm footing is part of the definition of the configuration, they shall be extended to provide leveling for the purpose of determining whether the vehicle meets this stability requirement. If other facilities such as a means of turntable leveling are provided to minimize the effect of the sloping surface, then those facilities may be utilized for the purpose of determining whether the vehicle meets this stability requirement.

8-5.5.1.3* None of the stability tests shall produce instability of the vehicle or cause permanent deformation of any components.

8-5.5.2 Stabilizers shall be provided if required to meet the stability requirements of 8-5.5.1.

8-5.5.2.1 If stabilizers are power operated, the controls shall be arranged so that the operator may view the stabilizers in motion. An audible alarm of not less than 87 dba at any position the stabilizer can be placed in shall sound when a stabilizer is moving.

8-5.5.2.2 The stabilizer system shall be deployed in not more than 90 sec from a stored position to the operating position.

8-5.5.2.3 The ground contact area for each stabilizer shall be such that a unit pressure of not greater than 75 psi (52726 kg/m^2) will be exerted over the ground contact area when the apparatus is fully loaded and the aerial device is carrying its rated capacity in every position allowed by the manufacturer. This may be accomplished with stabilizer pads in conjunction with the permanent mounted stabilizer shoes to meet the loading requirement of 75 psi (52726 kg/m^2). The stabilizer shoe shall be capable of swiveling in at least one direction. If the shoe swivels in one direction only, it shall swivel on an axis parallel to the longitudinal axis of the apparatus.

8-5.5.2.4 All stabilizers that protrude beyond the body of the apparatus shall be striped or painted with reflective material so as to indicate a hazard or obstruction.

8-5.5.2.5 All stabilizers that protrude beyond the body of the apparatus shall be provided with one or more red warning light(s) visible on the side of the vehicle where the stabilizer is located.

8-5.6 Control Devices.

8-5.6.1 Controls shall be provided at the driver's position to transfer power to the aerial device. A visual signal shall be provided at the driver's position to indicate when the operating mechanisms are engaged.

8-5.6.2 An interlock shall be provided that prevents operation of the water tower until the chassis spring brakes have been set and the transmission has been placed in neutral or the transmission is in the drive position with the driveline to the rear axle disengaged.

8-5.6.3 A governed engine speed control shall be provided to power the water tower at normal operating speeds as determined by the manufacturer and this standard. The governed engine speed control shall be automatically disengaged when the fire pump is operating.

8-5.6.3.1 If a power operated governed engine speed control is provided, an interlock shall be provided that allows operation of the engine speed control only after the chassis spring brakes have been set and the transmission is in neutral.

8-5.6.4* An interlock system shall be provided to prevent the lifting of the water tower from the travel position until all the stabilizers are in a configuration to meet the stability requirements of 8-5.5. The interlock system shall also prevent the moving of the stabilizers unless the water tower is in the travel position.

8-5.6.5* A water tower operator's position shall be provided on the apparatus so that the operator is not in contact with the ground. Provisions shall be made so that the pump operator is not in contact with the ground. Sign(s) shall be placed to warn the operator(s) of electrocution hazards.

8-5.6.6 Controls suitably lighted, clearly marked, and conveniently arranged shall be provided at the operator's position in order to:

(a) Elevate and lower booms
(b) Extend and retract booms, if applicable
(c) Rotate the turntable in either direction
(d) Operate nozzle functions
(e) Operate intercom, if applicable.

8-5.6.6.1 A method shall be provided to prevent unintentional movement of the water tower.

8-5.6.6.2 Controls shall permit the operator to regulate the speed of boom and turntable movements within the limits determined by the manufacturer and this standard. All controls shall be arranged so they can be operated by an operator with a gloved hand without disturbing any other controls.

8-5.6.7 When a three lever system is used to control the basic functions of the water tower, the levers shall be distinctively different from the other controls on the panel

and arranged adjacent to each other with the extension control being the left lever, the rotation control being the center lever, and the elevation control being the right lever.

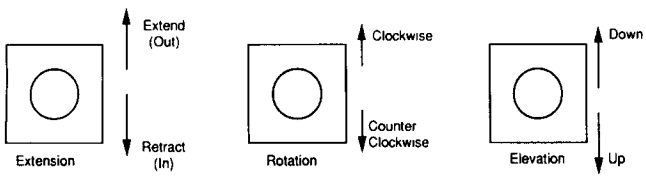

Figure 8-5.6.7 Control Lever Arrangement.

8-5.6.7.1 The water tower shall extend when the extension control is pushed up or forward (away from the operator).

8-5.6.7.2 If the rotation control has a forward/backward orientation or an up/down orientation, the turntable shall rotate clockwise when the rotation control is pushed up or forward (away from the operator). Otherwise, the rotational control handle shall move in the direction of rotation.

8-5.6.7.3 The water tower shall lower when the elevation control is pushed up or forward (away from the operator).

8-5.6.8 Where a multifunction control lever is furnished, it shall move in the direction of the function it controls, where possible.

8-5.6.9 All controls regulating movement of the aerial device shall automatically return to the neutral position upon release by the operator.

8-5.6.10 Indicating devices, suitably lighted, clearly marked, and conveniently arranged, shall be visible from the operator's position to:

(a) Indicate rungs are aligned for climbing, if applicable

(b) Indicate the alignment of the boom or sections with the travel bed

(c) Indicate elevation, extension, and capacity ratings or provide an equivalent load indicating system.

8-5.6.11 If the water tower incorporates a ladder, a second control station shall be furnished near the water tower nozzle and accessible to personnel on the ladder for control of all nozzle functions.

8-5.6.12 If a second control station is provided at the water tower nozzle, a weather resistant two-way voice communication system shall be provided between the water tower operator's control stations and the control station at the nozzle. The speaker/microphone at the nozzle control station shall allow for hands free operation.

8-5.7 Safety.

8-5.7.1 If the operator's position is on the turntable, the turntable platform shall be provided with a railing at least 42 in. (1070 mm) high.

8-5.7.2 Where the water tower includes moving cylinders or other moving parts, these shall be arranged so as to provide adequate hand clearance, or suitable hand guards shall be provided to prevent injury to the operator.

8-5.7.3 Lighting shall be provided at the base of the water tower arranged to illuminate the water tower in any position of operation.

8-5.7.4 A spotlight of not less than 75,000 candlepower shall be provided on the apparatus by which the operator may observe the effect of the stream from the water tower nozzle.

8-5.7.5 Provisions shall be made so that in the event of failure of the normal operating power source, an auxiliary source of power shall be readily available. The auxiliary power source shall be capable of returning the aerial device to a road travel position.

8-5.7.6 Where the operation of the water tower is accomplished by hydraulic means, the system shall be equipped with appropriate devices to prevent motion of the water tower in the event of any hydraulic hose failure.

8-5.7.7 Where the operation of the water tower is accomplished by other than hydraulic means, the system shall be designed to prevent motion of the water tower in the event of a power failure.

8-5.7.8 All components used to stabilize the water tower apparatus shall be designed to prevent instability in the event of a hydraulic hose failure or a power failure.

8-5.7.9 Where the design of the water tower incorporates a "knuckle," the knuckle shall either be equipped with position lights or continuously illuminated by boom lights. The knuckle shall be painted with reflective paint or provided with reflective striping.

8-5.8 Hydraulic System.

8-5.8.1 All hydraulic components whose failure could result in motion of the water tower shall have a minimum bursting strength of at least four (4) times the maximum operating pressure to which the component is subjected.

8-5.8.2 All hydraulic hoses, tubing, and fittings shall have a minimum bursting strength of at least three (3) times the maximum operating pressure to which the components are subjected.

8-5.8.3 All other hydraulic components shall have a minimum bursting strength of at least two (2) times the maximum operating pressure to which the components are subjected.

8-5.8.4 The hydraulic system shall be provided with an oil pressure gauge at the operating position.

8-5.8.5 Means shall be provided for readily checking and filling the hydraulic reservoir, which shall be conspicuously marked "Hydraulic Oil Only." The manufacturer shall provide proper instructions for checking and filling hydraulic reservoir.

8-5.8.6 The hydraulic system components shall be capable of maintaining, under all operating conditions, proper oil cleanliness and temperature to comply with the hydraulic oil manufacturer's recommendations.

8-5.9 Water Delivery System.

8-5.9.1 A permanently installed monitor with an automatic variable flow nozzle capable of a discharge range of at least 300-1000 gpm (1136-3785 L/min) shall be provided at the top of the tower and supplied by a permanent water system. The monitor shall be powered so as to allow the operator(s) to control its aimed direction. The monitor, as distinct from the supporting boom, shall provide for rotation through at least 45 degrees either side of center. The monitor shall also provide for elevation and depression of the nozzle through at least 30 degrees above and 105 degrees below the center line of the boom. The horizontal and vertical traverse of the monitor shall not exceed the water tower manufacturer's recommendation. If a variable pattern spray nozzle is provided, a control shall be provided at the operator's position to select the desired stream pattern.

8-5.9.1.1 Where more than one set of controls are provided, the set at the water tower operator's position shall be capable of overriding all others.

8-5.9.1.2 Where the water tower is equipped with a ladder, the monitor and nozzle shall be arranged such that they do not extend past the last rung of the outermost fly section or can swing completely out of the way so as not to hamper persons climbing onto and off of the tip of the ladder when it is positioned up to a window or other location.

8-5.9.2 A permanent water system shall be installed capable of delivering 1000 gpm (3785 L/min) at 100 psi (690 kPa) nozzle pressure with the water tower and nozzle positioned in any configuration allowed by the manufacturer. For water towers with a rated vertical height of 110 ft (33.5 m) or less, the friction loss (total system loss less head loss) between the monitor outlet and a point below the waterway swivel shall not exceed 100 psi (690 kPa) at 1000 gpm (3785 L/min) flow. A flow meter shall be installed in the water delivery system with the display at the operator's position.

8-5.9.3 The system, including the monitor, shall be designed to withstand the maximum operating pressure required to flow 1000 gpm (3785 L/min) at 100 psi (690 kPa) nozzle pressure at maximum elevation and extension.

8-5.9.4* A permanent gated connection capable of flowing 1000 gpm (3785 L/min) shall be provided between the fire pump and the waterway system. A gated auxiliary inlet to the waterway for supplying water from an external source shall be provided. A pressure gauge or flow meter shall be provided at that inlet.

8-5.9.5 A preset relief valve capable of protecting the waterway system by relieving pressure, through the dumping of water to the environment, shall be provided. Such dumping shall be via a system of piping terminating in an area facing away from the operator's position. The discharge end of the piping shall not have a threaded connection.

8-5.9.6* A $1\frac{1}{2}$-in. (38-mm) minimum drain valve shall be provided at the low point of the waterway system.

8-5.10 Structure.

8-5.10.1* All structural load supporting elements of the water tower, which are made of a ductile material, shall have a design stress of not more than 50 percent of the minimum yield strength of the material based on the combination of the live load and the dead load.

8-5.10.2 All structural load supporting elements of the water tower that are made of a nonductile material shall have a design stress of not more than 20 percent of the ultimate strength of the material, based on the combination of the live load and the dead load of the support structure.

8-5.10.3 Wire ropes, chains, and attaching systems used to extend and retract a telescopic water tower shall have a 5:1 safety factor based on ultimate strength under normal operating conditions. The factor of safety for the wire rope shall remain above 2:1 during any extension or retraction system stall. The minimum ratio of the diameter of wire rope used to the diameter of the sheave used shall be 1:12.

8-5.11 Quality Control.

8-5.11.1 The manufacturer and installer shall have in effect a complete and documented quality control program that will ensure complete compliance with the requirements of this standard.

8-5.11.2 The quality control program shall include 100 percent nondestructive testing of all critical structural components of the water tower. The manufacturer shall determine the types of nondestructive testing (NDT) to be conducted. The procedures used for NDT shall comply with the appropriate standards defined in 8-5.11.4. All NDT procedures shall be fully documented with respect to extent of examination, method of testing, and inspection techniques. All NDT testing shall be done in accordance with the American Society for Non-Destructive Testing SNT-TC-1A, *Recommended Practice*. All testing shall be performed by ASNT Level II NDT technicians certified in the test methods used.

8-5.11.3 Welds for all structural load supporting elements shall be performed by certified welders under the guidelines of AWS D1.1, *Structural Welding Code—Steel*, and

AWS D1.2, *Structural Welding Code—Aluminum.* Welding performed by machines shall be considered equivalent to welding performed by certified welders.

The manufacturer and the installer shall establish applicable welding quality assurance procedures for all weldments. Methods of nondestructive testing shall be described in the manufacturer's quality assurance procedures. The manufacturer shall designate the welds to be examined, the extent of examination, and the type of testing.

8-5.11.4 Nondestructive Testing Procedure.

8-5.11.4.1 All ultrasonic inspections shall be conducted in accordance with the following American Society for Testing and Materials (ASTM) standards:

(a) ASTM E114, *Practice for Ultrasonic Pulse-Echo Straight-Beam Examination by the Contact Method*

(b) ASTM E797, *Standard Practice for Measuring Thickness by Manual Ultrasonic Pulse Echo Contact Method*

(c) ASTM E500, *Standard Terminology Relating to Ultrasonic Examination.*

8-5.11.4.2 All magnetic particle inspections shall be conducted in accordance with the following American Society for Testing and Materials (ASTM) standards:

(a) ASTM E709, *Practice for Magnetic Particle Examination*

(b) ASTM E269, *Definitions of Terms Relating to Magnetic Particle Examination.*

8-5.11.4.3 All liquid penetrant inspections shall be conducted in accordance with the following American Society for Testing and Material (ASTM) standards:

(a) ASTM E165, *Standard Practice for Liquid Penetrant Inspection Method*

(b) ASTM E270, *Definitions of Terms Relating to Liquid Penetrant Inspection.*

8-5.11.4.4 All radiographic inspection shall be conducted in accordance with the following American Society for Testing and Materials (ASTM) standards:

(a) ASTM E1032, *Method for Radiographic Examination of Weldments*

(b) ASTM E586, *Definition of Terms Relating to Gamma and X-Radiography.*

8-5.11.4.5 All electrical conductivity measurements shall be conducted in accordance with the following American Society for Testing and Materials (ASTM) standards:

(a) ASTM E1004, *Test Method for Electromagnetic Measurements of Electrical Conductivity*

(b) ASTM E268, *Definition of Terms Relating to Electromagnetic Testing.*

8-5.11.4.6 All hardness readings shall be conducted in accordance with the following American Society for Testing and Materials (ASTM) standards:

(a) ASTM E6, *Standard Definitions of Terms Relating to Methods of Mechanical Testing*

(b) ASTM E10, *Test Method for Brinell Hardness of Metallic Materials*

(c) ASTM E18, *Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials*

(d) ASTM E92, *Test Method for Vickers Hardness of Metallic Materials*

(e) ASTM B647, *Test Method for Indentation Hardness of Aluminum Alloys by Means of a Webster Hardness Gauge*

(f) ASTM B648, *Test Method for Indentation Hardness of Aluminum Alloys by Means of a Barcol Impressor.*

8-5.11.4.7 All acoustic emission inspections shall be conducted in accordance with the following American Society for Testing and Materials (ASTM) standards:

(a) ASTM E610, *Definition of Terms Relating to Acoustic Emission*

(b) ASTM E569, *Practice for Acoustic Emission Monitoring of Structures During Controlled Stimulation*

(c) ASTM E650, *Guide for Mounting Piezoelectric Acoustic Emission Sensors.*

8-5.12 Signs.

8-5.12.1 Legible, permanent signs that provide operational directions, and warning and caution shall be installed in positions readily visible to the operator(s).

8-5.12.1.1 Operating signs shall describe the function of each control and provide operating instructions.

8-5.12.1.2 Warning and caution signs shall indicate hazards inherent in the operation of the water tower. These hazards may include but not be limited to:

(a) Electrical hazards involved where the water tower does not provide protection to the personnel from contact with or near proximity to an electrically charged conductor.

(b) Electrical hazards involved where the water tower does not provide protection to ground personnel who may contact the vehicle when in contact with energized electrically charged conductors.

(c) Hazards from stabilizer motion.

(d) Hazards that may result from failure to follow manufacturer's operating instructions.

8-5.12.2 Identification signs shall disclose the following information relative to the water tower.

1. Make
2. Model
3. Insulated or noninsulated
4. Serial number
5. Date of manufacture
6. Rated load capacity
7. Rated vertical height
8. Rated horizontal reach
9. Maximum hydraulic system pressure, if applicable
10. Hydraulic oil requirements, if applicable.

Chapter 9 Test and Delivery Data Requirements

9-1 Pumper Certification Tests. The pumper shall be tested at the manufacturer's approved facility and certified by an independent testing organization approved by the purchaser. The certification shall include at least the pumping test (9-2), the pumping engine overload test (9-3), the pressure control device test (9-4), the priming device test (9-5), the vacuum test (9-6), and the water tank to pump flow test (9-7). If the pumper is equipped with a water tower, the tests defined in 9-8 shall also be conducted and certified.

9-2 Pumping Tests.

9-2.1 Conditions for Test.

9-2.1.1 The test site shall be adjacent to a supply of clear water at least 4 ft (1.2 m) deep, with the water level not more than 10 ft (3 m) below the center of the pump intake, and close enough to allow the suction strainer to be submerged at least 2 ft (0.6 m) below the surface of the water when connected to the pump by 20 ft (6 m) of suction hose.

9-2.1.2 Tests shall be performed when conditions are as follows:

Air Temperature:	0°F to 100°F (−18°C to 38°C)
Water Temperature:	35°F to 90°F (2°C to 32°C)
Barometric Pressure:	(corrected to sea level) 29 in. Hg (98.2 kPa), minimum

9-2.1.3 Engine driven accessories shall not be functionally disconnected or otherwise rendered inoperative during the tests. If the chassis engine drives the pump, all headlights, running lights, warning lights, and air conditioner(s), if provided, shall be operating during the pumping portion of this test.

9-2.1.4 All structural enclosures such as floorboards, gratings, grills, heat shields, etc., not furnished with a means for opening them in normal service shall be kept in place during the tests.

9-2.2 Equipment.

9-2.2.1 Suction hose shall be of the appropriate size for the rated capacity of the pump (*see 4-1.3.1*).

9-2.2.2 A suction strainer that will allow flow with total friction and entrance loss not greater than that specified in Table 4-1.3.1(b) of this standard shall be provided.

9-2.2.3 Sufficient fire hose shall be provided to allow discharge of rated capacity to the nozzles or other flow measuring equipment without exceeding a flow velocity of 35 fps (10.7 mps) [approximately 500 gpm (1900 L/min) for 2½-in. (65-mm) hose].

9-2.2.4 Where nozzles are used they shall be smoothbore; inside diameters shall be from ¾ in. (19 mm) to 2½ in. (65 mm). Pitot tubes, if used, shall be approved by the authority having jurisdiction. Other equipment such as flow meters, volumetric tanks, or weigh tanks used for measuring the flow shall be approved by the authority having jurisdiction.

9-2.2.5 All test gauges shall meet the requirements for Grade A gauges as defined in ANSI B40.1, *Gauges—Pressure Indicating Dial Type—Elastic Element*, and shall be at least size 3½ per ANSI B40.1, Figure 6. The suction gauge shall have a range of 30 in. Hg (100 kPa) vacuum to zero for a vacuum gauge or 30 in. Hg (100 kPa) vacuum to 150 psig (1035 kPag) for a compound gauge. The discharge pressure gauge shall have a range of zero to 400 psig (0 to 2758 kPag). Pitot gauges shall have a range of at least zero to 160 psig (1103 kPag). A mercury manometer may be used in lieu of a suction gauge. All gauges shall have been calibrated in the month preceding the tests. Calibrating equipment shall consist of a dead weight gauge tester or a master gauge meeting the requirements for Grade 3A or 4A gauges as defined in ANSI B40.1 that has been calibrated by its manufacturer within the preceding year.

9-2.2.6 All test gauge connections shall include "snubbing" means, such as needle valves to damp out rapid needle movements, unless the gauges are liquid filled.

9-2.2.7 Speed measuring equipment shall consist of either a tachometer measuring revolutions per minute, or a revolution counter and stopwatch. When a revolution counter and stopwatch are used, the stopwatch shall be equipped with a full sweep second hand or shall be of a digital reading type. All speed measurements shall be taken at the checking shaft outlet.

9-2.2.8 Where tests are performed inside a structure or elsewhere having limited air circulation, carbon monoxide monitoring equipment shall be used. Such equipment shall be checked and calibrated regularly and shall include a suitable warning device.

9-2.3* Procedure. The ambient air temperature, water temperature, vertical lift, elevation of test site, and atmospheric pressure (corrected to sea level) shall be determined and recorded prior to and after each pump test. The engine, fire pump, transmission, and all parts of the apparatus shall exhibit no undue heating, loss of power, overspeed, or other defect during the entire test.

The pumper shall be subjected to a 3-hr pumping test consisting of 2 hr of continuous pumping at rated capacity at 150 psi (1035 kPa) net pump pressure, followed by ½ hr of continuous pumping at 70 percent of rated capacity at 200 psi (1380 kPa) net pump pressure and ½ hr of continuous pumping at 50 percent of rated capacity at 250 psi (1725 kPa) net pump pressure. The pump shall not be stopped until after the 2-hr test at rated capacity unless it becomes necessary to clean the suction strainer. The pump may be stopped between tests to allow changing hose and/or nozzles, to clean the strainer, or to add fuel.

The capacity, discharge pressure, suction pressure, and engine speed shall be recorded at least every 15 min. The average net pump pressure shall be calculated and recorded based on the average values for discharge and suction pressure.

9-3 Pumping Engine Overload Test. The pumper shall be subjected to an overload test consisting of pumping rated capacity at 165 psi (1138 kPa) net pump pressure for at least 10 min. This test may be performed immediately following the 2-hr pumping test of rated capacity at 150 psi (1035 kPa).

The capacity, discharge pressure, suction pressure, and engine speed shall be recorded once during the overload test.

9-4 Pressure Control Device Test. The pressure control device on the fire pump shall be tested as follows:

(a) Pump shall be operated at draft, delivering rated capacity at 150 psig (1035 kPag) discharge pressure.

(b) The pressure control device shall be set in accordance with the manufacturer's instructions to maintain the discharge pressure at 150 psig (1035 kPag).

(c) All discharge valves shall be closed no more rapidly than in 3 sec time and no more slowly than in 10 sec time. The rise in discharge pressure shall not exceed 30 psi (207 kPa) and shall be recorded.

(d) The original conditions have been reestablished, and pumping rated capacity at 150 psig (1035 kPag) shall be reestablished. The discharge pressure shall be reduced to 90 psig (620 kPa) by throttling the engine fuel supply, with no change to the discharge valve settings, hose, or nozzles.

(e) The pressure control device shall be set according to the manufacturer's instructions to maintain 90 psig (620 kPa) discharge pressure.

(f) All discharge valves shall be closed no more rapidly than in 3 sec time and no more slowly than in 10 sec time. The rise in discharge pressure shall not exceed 30 psi (207 kPa) and shall be recorded.

(g) The pump shall be operated at draft pumping 50 percent of rated capacity at 250 psig (1725 kPa) discharge pressure.

(h) The pressure control device shall be set in accordance with the manufacturer's instructions to maintain 250 psig (1725 kPa) discharge pressure.

(i) All discharge valves shall be closed no more rapidly than in 3 sec time and no more slowly than in 10 sec time. The rise in discharge pressure shall not exceed 30 psi (207 kPa) and shall be recorded.

9-5 Priming Device Test.

9-5.1 With all openings to the pump closed, the primer shall be operated in accordance with the manufacturer's instructions. The maximum vacuum attained shall be at least 22 in. Hg (74.5 kPa). At altitudes above 2000 ft (610 m) the vacuum attained may be less than 22 in. Hg (74.5 kPa) by 1 in. Hg (3.4 kPa) per 1000 ft (305 m) of altitude above 2000 ft (610 m).

9-5.2 With the apparatus set up for the pumping test the primer shall be operated in accordance with the manufacturer's instruction until the fire pump has been primed and is discharging water. The interval from the time the primer was started until the time the fire pump is discharging water shall be noted. This test may be performed in connection with priming the pump for the pumping test.

The time required to prime the fire pump if rated capacity is 1250 gpm (4732 L/min) or less shall not exceed 30 sec. If the rated capacity is 1500 gpm (5678 L/min) or more, the time to prime shall not exceed 45 sec. An additional 15 sec shall be allowed on these time requirements for apparatus equipped with auxiliary 4-in. (100-mm) or larger front and/or rear intake piping.

9-6 Vacuum Test. A vacuum test shall be performed and shall consist of subjecting the interior of the pump, with capped intake and uncapped discharge outlets, to a vacuum of 22 in. Hg (74.5 kPa) by means of the pump priming device. The vacuum shall not drop more than 10 in. Hg (33.9 kPa) in 5 min. The primer shall not be used after the 5-min test period has begun. The engine shall not be operated at any speed greater than the no-load governed speed during this test.

9-7 Water Tank to Pump Flow Test. A water tank to pump flow test shall be conducted as follows:

(a) The water tank shall be filled until it overflows.

(b) All intakes to the pump shall be closed.

(c) The tank fill line and by-pass cooling line shall be closed.

(d) Hose lines and nozzles suitable for discharging water at a 500 gpm (1900 L/min) flow rate shall be connected to one or more discharge outlets.

(e) The tank to pump valve and the discharge valves leading to the hose lines and nozzles shall be fully opened.

(f) The engine throttle shall be adjusted until the 500 gpm (1900 L/min) flow rate -0, + 5 percent is established. The discharge pressure shall be recorded.

(g) The discharge valves shall be closed and the water tank refilled. The by-pass line may be opened temporarily if needed to keep the water temperature in the pump within acceptable limits.

(h) The discharge valves shall be reopened fully and the time noted. If necessary the engine throttle shall be adjusted to maintain the discharge pressure recorded as noted in (f).

(i) When the discharge pressure drops by 5 psi (34 kPa) or more, the time shall be noted and the elapsed time from the opening of the discharge valves calculated and recorded.

A 500 gpm (1900 L/min) tank to pump flow rate shall be maintained until 80 percent of the rated capacity of the tank has been discharged. The volume discharged shall be calculated by multiplying the rate of discharge in gpm times the time in minutes elapsed from the opening of the discharge valves until the discharge pressure drops by at least 5 psi (34 kPa).

9-8 Water Tower Certification Tests. The completed water tower apparatus shall be tested at the manufacturer's approved facility and certified by an independent testing organization approved by the purchaser.

9-8.1 The water tower shall be inspected and tested in accordance with the requirements for water towers contained in NFPA 1914, *Standard for Testing Fire Department Aerial Devices*, including all nondestructive testing prior to being subjected to the tests defined in 9-8.2 through 9-8.5.

9-8.2 The pumper shall be placed on a firm, level surface. If having the stabilizers extended is part of the configuration, the stabilizers shall be extended to a firm footing. A load of 1½ times the rated capacity shall be suspended from the tip of the water tower when it is in the position of least stability. The vehicle shall show no signs of instability.

9-8.3 The pumper shall be placed on a firm surface sloping downward at 5 degrees in the direction most likely to cause overturning. If having the stabilizers extended is part of the configuration, the stabilizers shall be extended to a firm footing. A load of 1⅓ times the rated capacity shall be suspended from the tip of the water tower when it is in the position of least stability. The vehicle shall show no signs of instability.

9-8.4 If the water tower has a rated vertical height of 110 ft (33.5 m) or less, standard model flow test data shall be provided to the purchaser. If the water system has been modified from the standard model configuration, a new flow test shall be conducted to determine that the friction loss in the water system between the base of the swivel and the monitor outlet does not exceed 100 psi (690 kPa) with 1000 gpm (3785 L/min) flowing and the water system at full extension.

9-8.5 A flow test shall be conducted to determine that the water system is capable of flowing 1000 gpm (3785 L/min) at 100 psi (690 kPa) nozzle pressure with the water tower at full elevation and extension when supplied by the fire pump on the pumper. The intake pressure to the fire pump shall not exceed 20 psi (138 kPa).

9-9 Manufacturer's Pre-Delivery Tests. The manufacturer shall conduct the following tests prior to delivery of the apparatus. If the purchaser specifies, these tests shall also be certified by an independent testing organization approved by the purchaser.

9-9.1 Water Tank Capacity Test. A water tank capacity test shall be conducted as follows:

(a) Fill the tank until water exits the top fill opening or the tank overflows.

(b) Weigh the apparatus to determine the tank full weight (TFW).

(c) Empty the water tank.

(d) Weigh the apparatus to determine the tank empty weight (TEW).

(e) The rated tank capacity shall be calculated as (TFW – TEW)/8.34. A ±2 percent tolerance is acceptable to account for measurement tolerances of commercial scales.

9-9.2 Piping Hydrostatic Test.

9-9.2.1 The pump and its connected piping system shall be hydrostatically tested to 250 psi (1725 kPa). The hydrostatic test shall be conducted with the tank fill line valve, the by-pass line valve, and the tank to pump valve closed. All discharge valves shall be open and the outlets capped. All intake valves shall be closed, and nongated intakes shall be capped. This pressure shall be maintained for 3 min.

9-9.2.2 If the pumper is equipped with a water tower, the piping for the waterway system, including the monitor, shall be hydrostatically tested at the maximum operating pressure required to flow 1000 gpm (3785 L/min) at 100 psi (690 kPa) nozzle pressure at maximum elevation and extension.

9-9.3 Electrical System Tests. If the apparatus is equipped with a 120/240 volt electrical system, the wiring and associated equipment shall be tested.

9-9.3.1 The wiring and associated receptacles shall be subjected to a 1-min, 900-V dielectric voltage withstand test with any switches in the circuit(s) closed between live parts, including neutral and the vehicle frame. This test shall be conducted after all body work has been completed.

9-9.3.2* Electrical polarity checks shall be made of permanently wired equipment and receptacles to determine that connections have been properly made.

9-9.3.3 An operational test shall be conducted to ensure that any equipment that is permanently attached to the electrical system is properly connected and in working order.

9-9.3.4 The results of the test required in 9-9.3.1 through 9-9.3.3 shall be recorded and provided to the purchaser at the time of delivery.

9-9.4 Foam System Tests. If the apparatus is equipped with a foam system, the accuracy of the foam proportioning system shall be tested.

9-9.4.1* The foam system shall proportion foam concentrate into water within plus or minus 10 percent of the recommended concentration across the range of the design flows.

9-9.4.2 Pressurized gas foam system piping, subject to the specified system working pressure, shall be tested at the specified system working pressure.

9-10 Road Tests.

9-10.1 Road tests shall be conducted prior to delivery or within ten days after delivery, by the contractor's representative in the presence of such person or persons as the purchaser may designate in the requirements for delivery. The tests shall be conducted at such locations and in such a manner as not to violate the local, state, or federal traffic laws.

9-10.2 The apparatus shall be fully equipped and loaded as defined in 3-1.1. The tests shall be conducted on dry paved roads in good condition. The engine shall not be operating in excess of the maximum no-load governed speed.

9-10.3 Acceleration tests shall consist of two runs in opposite directions over the same route.

9-10.3.1 From a standing start the vehicle shall attain a true speed of 35 mph (56 kmph) within 25 sec.

9-10.3.2 From a steady speed of 15 mph (24 kmph) the vehicle shall accelerate to a true speed of 35 mph (56 kpmh) within 30 sec. This shall be accomplished without moving the gear selector.

9-10.3.3 The vehicle shall attain minimum top speed of not less than 50 mph (80 kpmh).

9-10.4 The service brakes shall bring the fully laden apparatus to a complete stop from an initial speed of 20 mph (32 kmph) in a distance not exceeding 35 ft (10.7 m) by actual measurement on a substantially hard level surface road that is free of loose material, oil, or grease.

9-11* Tests on Delivery. If acceptance tests are desired at the point of delivery, they shall be run in accordance with the provisions of Chapter 9 and duplicate the portions of the tests that the purchaser specifies. Aerial device stability tests shall not be run other than at the manufacturer's facility.

9-12 Data Required of the Contractor.

9-12.1 The contractor shall supply, at the time of delivery, at least one copy of:

(a) Engine manufacturer's certified brake horsepower curve for the engine furnished showing the maximum no-load governed speed.

(b)* Manufacturer's record of pumper construction details and if equipped with a water tower, all technical information required for inspection to NFPA 1914, *Testing Fire Department Aerial Devices*.

(c) Pump manufacturer's certification of suction capability (*see 4-1.3.1*).

(d) Pump manufacturer's certification of hydrostatic test (*see 4-3.2*).

(e) The certification of inspection and test by a qualified third party testing organization approved by the purchaser (*see Section 9-1*).

(f) A copy of the apparatus manufacturer's approval for stationary pumping applications (*see 4-2.1*).

(g) Weight documents from a certified scale showing actual loading on the front axle, rear axle(s), and overall vehicle (with the water tank full but without personnel, equipment, and hose) shall be supplied with the completed vehicle to determine compliance with Section 3-1.

9-12.2 A test plate shall be provided at the pump operator's position that gives the rated discharges and pressures together with the speed of the engine as determined by the certification test for each unit, the position of parallel-series pump as used, and the no-load governed speed of the engine as stated by the engine manufacturer on a certified brake horsepower curve. The plate shall be completely stamped with all information at the factory and attached to the vehicle prior to shipping.

Chapter 10 Referenced Publications

10-1 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.

10-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 70, *National Electrical Code*, 1990 edition

NFPA 1914, *Standard for Testing Fire Department Aerial Devices*, 1988 edition

NFPA 1931, *Standard on Design of and Design Verification Tests for Fire Department Ground Ladders*, 1989 edition

NFPA 1961, *Standard for Fire Hose*, 1987 edition

NFPA 1963, *Standard for Screw Threads and Gaskets for Fire Hose Connections*, 1985 edition

NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for Fire Fighters*, 1987 edition

NFPA 1983, *Standard on Fire Service Life Safety Rope, Harnesses, and Hardware*, 1990 edition

10-1.2 AAMVA Publications. American Association of Motor Vehicle Administrators, 4200 Wilson Blvd., Suite 600, Arlington, VA 22203.

10-1.3 ANSI Publications. American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

ANSI/UL 92-1988, *Standard for Fire Extinguisher and Booster Hose*

ANSI B40.1-1985, *Gauges—Pressure Indicating Dial Type—Elastic Element*

10-1.4 ASME Publication. American Society of Mechanical Engineers, 345 E. 47th Street, New York, NY 10017.

ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 1

10-1.5 ASNT Publicaton. American Society for Nondestructive Testing, Inc., 4153 Arlingate Plaza, Columbus, OH 43228.

ASNT SNT-TC-1A-1988, *Recommended Practice*

10-1.6 ASTM Publications. American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM B647-1984, *Test Method for Indentation Hardness of Aluminum Alloys by Means of a Webster Hardness Gauge*

ASTM B648-1984, *Test Method for Indentation Hardness of Aluminum Alloys by Means of a Barcol Impressor*

ASTM E6-1989, *Standard Definitions of Terms Relating to Methods of Mechanical Testing*

ASTM E10-1984, *Test Method for Brinell Hardness of Metallic Materials*

ASTM E18-1989, *Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials*

ASTM E92-1987, *Test Method for Vickers Hardness of Metallic Materials*

ASTM E114-1990, *Practice for Ultrasonic Pulse-Echo Straight-Beam Examination by the Contact Method*

ASTM E165-1983, *Practice for Liquid Penetrant Inspection Method*

ASTM E268-1989, *Definitions of Terms Relating to Electromagnetic Testing*

ASTM E269-1988, *Definitions of Terms Relating to Magnetic Particle Examination*

ASTM E270-1990, *Definitions of Terms Relating to Liquid Penetrant Inspection*

ASTM E500-1986, *Standard Terminology Relating to Ultrasonic Examination*

ASTM E569-1985, *Practice for Acoustic Emission Monitoring of Structures During Controlled Stimulation*

ASTM E586-1988, *Standard Definitions of Terms Relating to Gamma and X-Radiography*

ASTM E610-1989, *Definitions of Terms Relating to Acoustic Emission*

ASTM E650-1985, *Guide for Mounting Piezoelectric Acoustic Emission Sensors*

ASTM E709-1985, *Practice for Magnetic Particle Examination*

ASTM E797-1990, *Standard Practice for Measuring Thickness by Manual Ultrasonic Pulse-Echo Contact Method*

ASTM E1004-1984, *Test Method for Electromagnetic Measurements of Electrical Conductivity*

ASTM E1032-1985, *Method for Radiographic Examination of Weldments*

10-1.7 AWS Publications. American Welding Society, Inc., 550 N.W. Lejunne Road, P.O. Box 351040, Miami, FL 33135.

AWS D1.1-1990, *Structural Welding Code—Steel*

AWS D1.2-1983, *Structural Welding Code—Aluminum*

10-1.8 CGA Publication. Compressed Gas Association, Crystal Gateway 1, Suite 501, 1235 Jefferson Davis Highway, Arlington, VA 22202.

S-1.1-1989 *Pressure Relief Devices for Cylinders for Compressed Gases*

10-1.9 Federal Government Publications. Superintendent of Documents, U.S. Government Printing Office, Washing ton, DC 20402.

49 CFR 178C *Specifications for Cylinders*

49 CFR 393.94(c) *Test Procedure for Vehicle Interior Noise Levels*

Federal Specification for Reflectivity, LS-300

10-1.10 NEMA Publication. National Electrical Manufacturers Association, 2101 L Street NW, Suite 300, Washington, DC 20037.

WD 6-1988, *Dimensional Requirements for Wiring Devices*

10-1.11 SAE Publications. Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

SAE J348-1968, *Standard for Wheel Chocks*

SAE J541-1989, *Voltage Drop for Starting Motor Circuits*

SAE J551-1985, *Performance Levels and Methods of Measurement of Electromagnetic Radiation from Vehicles and Devices (30-1000 MHZ)*

SAE J595-1983, *Flashing Warning Lamps for Authorized Emergency, Maintenance, and Service Vehicles*

SAE J683-1985, *Tire Chain Clearance—Trucks, Buses, and Combinations of Vehicles*

SAE J845-1990, *360 Degree Warning Lamp for Authorized Emergency, Maintenance, and Service Vehicles*

SAE J994-1985, *Alarm—Backup—Electric—Performance, Test, and Application*

SAE J1128-1988, *Low Tension Primary Cable*

SAE J1292-1981, *Automobile, Truck, Truck-Tractor, Trailer, and Motor Coach Wiring*

SAE J1318-1986, *Gaseous Discharge Warning Lamp for Authorized Emergency, Maintenance, and Service Vehicles.*

SAE J1849-1989, *Emergency Vehicle Sirens*

10-1.12 TRA Publication. The Tire and Rim Association, Inc., 3200 West Market Street, Akron, OH 44313.

TRA Yearbook

Appendix A

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

A-1-1 This standard is one document in a series of 4 standards for the design of specific types of fire apparatus. The 4 standards, their NFPA designation, and a definition of the apparatus are:

NFPA 1901, *Pumper Fire Apparatus*. A vehicle equipped with a permanently mounted fire pump of 750 gpm (2850 L/min) rated capacity or greater, a water tank of at least 500 gal (1900 L), and hose body. The primary purpose of this type of apparatus is to combat structural and associated fires.

NFPA 1902, *Initial Attack Fire Apparatus*. A vehicle equipped with an attack pump [250 through 700 gpm (950 through 2650 L/min)], a water tank, and minimum hose and equipment that is designed primarily for rapid response and initiating a fire attack on structural, vehicular, or vegetation fires and supporting associated fire department operations.

NFPA 1903, *Mobile Water Supply Fire Apparatus (Tanker).* A vehicle equipped with a water tank of at least 1000 gal (3800 L) and designed primarily for transporting (pickup, transporting, and delivering) water to fire emergency scenes to be applied by other vehicles or pumping equipment.

NFPA 1904, *Aerial Ladder and Elevating Platform Fire Apparatus.* A vehicle equipped with a permanently mounted, power operated aerial ladder or with a passenger carrying platform attached to the uppermost boom of a series of telescoping and/or articulating booms and designed to provide rescue capability from elevated positions, and the positioning of fire fighters and elevated master streams for fire suppression tasks.

A-1-3 The purchase of new fire apparatus involves a major investment and should be treated as such. Fire apparatus is complex mechanical equipment that should not be purchased in a haphazard manner. Purchase should be made only after a detailed study of the department's fire apparatus needs, taking into consideration other equipment the department may own or plan to buy.

The local fire chief and fire department staff know the conditions of use to which the apparatus will be put. However, competent advice should also be obtained from knowledgeable and informed sources including experienced fire chiefs, fire protection engineers, trade journals, training instructors, maintenance personnel, and fire equipment and component manufacturers. The fire insurance rating authority should also be consulted.

The study should look at not only current operations and risks protected but how these may change over the life of the fire apparatus. The fire department, whether paid or volunteer, tax or solicitation supported, has an obligation to the citizens it protects to provide apparatus that will best protect persons and property. Bargain-rate, ill-suited fire apparatus can be a waste of taxpayers' money. Fire apparatus purchased for other than fire fighting utility may give a false sense of security.

Writing the Specifications. This standard provides the basic technical requirements that new fire apparatus are expected to meet. Fire apparatus manufacturers are expected to be familiar with the standard. It is recognized that many purchasers will desire additional features of operation over and above the requirements of this basic standard. The Appendix to this standard should be used to assist in the evaluation and determination of a fire department's basic needs.

The equipment lists presented in this standard relate to the operations to which a pumper is normally assigned. Since new apparatus must be fully equipped in order to provide effective service, this standard contemplates the provision of new equipment along with the apparatus.

This standard is designed to ensure sound equipment capable of good performance, with inclusion of restrictive features only where needed to specify minimum requirements. The tests are an important feature and should be required to ensure that the completed apparatus will meet the specified performance.

Since the passage of Public Law 89-563, the National Traffic and Motor Vehicle Safety Act of 1966, the federal government has adopted certain motor vehicle safety standards applicable to all manufacturers of trucks including fire trucks. It is unlawful for a manufacturer to deliver a truck not in compliance with these federal standards. These federal safety standards are frequently changed, and their provisions make the incorporation of certain features and devices mandatory. Apparatus manufacturers face heavy penalties for infraction of these rules and therefore cannot build to specifications that would require them to perform unlawfully or to delete required items or to include any that are illegal.

Additional requirements are placed on both apparatus and engine manufacturers that are based upon the Clean Air Act and enforced by the Environmental Protection Agency. These standards have resulted in major changes in the performance of many engines. Neither the engine manufacturer nor the apparatus manufacturer may modify engines once they are certified to EPA. The EPA standards often make mandatory the installation of larger engines than may have been previously used, in order to obtain the same apparatus performance.

Many purchasers find it is desirable to provide for an interim inspection at the assembly plant of the successful bidder. The advantages of such a provision include the opportunity to evaluate construction prior to final assembly and painting. The specifications should detail the particulars of such an inspection trip.

The chief of the fire department (or a designated representative) normally exercises the acceptance authority following satisfactory completion of tests and inspections for compliance with purchase specifications. The specifications should provide details of delivery expectations, including the desired training, the required acceptance tests, and who is responsible for the various costs associated with the delivery and acceptance.

The purchaser should also define, within the specifications, the warranty desired for the completed apparatus. The warranty is a written guarantee of the integrity of the apparatus or its components that defines the manufacturer's responsibility within a given time frame. The warranty is sometimes extended for a second warranty period beyond the terms of the basic warranty for specific components such as the engine, pump, frame, water tank, etc.

The purchaser may want a warranty bond to ensure any warranty work will be performed, even if the apparatus manufacturer should go out of business. A warranty bond is a third party secured bond established by the manufacturer before delivery of a vehicle to guarantee workmanship, quality material, or other stated performance of the vehicle components.

Finally, it is recommended that the fire chief, fire department staff, or the committee assigned to develop the specifications consult with the municipal attorney, engineer, and other appropriate officials for assistance in developing the detailed specifications.

Obtaining and Studying Proposals. When the specifications have been completed, they should be distributed to apparatus manufacturers and contractors with a request for bids or proposals to furnish the specified apparatus. The request should specify a date, time, and place for the formal openings of the bids. This date should provide at

least one month for the engineering departments of apparatus manufacturers to study the specifications and estimate the cost of the apparatus. More time may be required if engineering drawings of the proposed apparatus are required.

The request should also state the time in which the purchaser expects the bidder to honor the bid price and whether a bid bond is required. The bid bond guarantees that if a contract is awarded to the bidder within the allowed time frame, the bidder will enter into the contract under the terms of the bid.

It is recommended that a pre-bid meeting be held between the purchaser of a piece of fire apparatus and apparatus manufacturers or their agents prior to the official release of an apparatus specification. The meeting is designed to allow for a detailed review of the draft specification by all present at the meeting. Problems with the specification, ideas on how to provide the purchaser with the desired apparatus in other ways, clarifications of the purchaser's intent, and other questions can be resolved prior to the formal bid process. The meeting can often solve misunderstandings or problems prior to their occurrence.

With a performance specification, it is usually possible to obtain more favorable bids since there is genuine competition, and the specifications are not overly restrictive. Manufacturers' proposals may include amendments and exceptions. Frequently, these changes are offered to meet price requirements or because individual manufacturers may prefer to build apparatus in a manner more convenient to them. If the intent of the original specification is not changed and the bid is favorable, the purchaser should consider accepting these amendments with the approval of the purchasing authority. On the other hand, extreme care should be taken not to permit exceptions that merely devalue the apparatus and give a bidder an advantage.

The purchaser should study the proposals, look for deviations from the specifications, and obtain clarification where necessary. If the purchaser has specifically provided for alternates when calling for bids, extra care must be exercised when evaluating the proposals as combinations of complicated bid information will need careful analysis. The financial arrangements, a delivery date, and the method of delivery should be stipulated and agreed to by the purchasing authority.

Awarding the Contract. With the award of a contract, it is important for the purchasing authority to understand exactly who the contract is with and what the relationship is with the apparatus manufacturer. Some apparatus manufacturers work through a dealer network where the dealer purchases the apparatus from a manufacturer, including taking title, and then resells the apparatus to the purchasing authority. Other manufacturers work through sales agents or representatives who solicit and negotiate a contract between a purchasing authority and a manufacturer but who never take title to the apparatus. This difference can affect where the responsibility lies for the proper fulfillment of the contract.

Some purchasing authorities require a performance bond as part of the contract. A performance bond is a bond executed in connection with a contract that guarantees that the contractor will fulfill all of the undertakings, covenants, terms, conditions, and agreements contained in the contract. Should the contractor fail to meet the terms of the contract, the bonding company will be responsible for the difference in cost between the original contract price and the new price of the apparatus when it has to be supplied by another contractor.

Before signing a contract, the purchaser should make certain that the successful bidder has a complete and thorough understanding of the specifications. If there are any disagreements, these should be resolved in writing and made part of the contract. If any changes are agreed upon, these should be stated in writing and be signed by both parties. The contract should not be signed until the fire chief (or a designee) and the purchasing authority are satisfied.

Acceptance. When the apparatus is ready for delivery and acceptance, the purchaser has a responsibility to check the completed apparatus carefully against the specifications and contract to ensure all that was required is being delivered. This includes witnessing any required acceptance tests and verifying that the gross vehicle weight and the axle weight distribution are within the chassis and axle ratings.

The purchaser should also arrange for any training included as part of the delivery and ensure that it is properly delivered.

Only when the purchaser is totally satisfied that the contract has been fulfilled should payment be authorized.

A-1-4 Net Pump Pressure. When operating from a hydrant the net pump pressure is typically less than the discharge pressure. For example, if the discharge pressure gauge reads 150 psi, and the intake (suction) gauge reads 20 psi, the net pump pressure equals 130 psi. When operating from draft, the net pump pressure will be above the discharge pressure. For example, if the discharge pressure gauge is reading 145 psi and the intake (suction) gauge is reading 10 in. of mercury (Hg), the net pump pressure will be 150 psi (1 in. Hg = .5 psi).

A-2-1 When local operating conditions necessitate apparatus of unusual design, the purchaser should carefully define the special requirements in the specifications. Height, width, under-vehicle clearance, wheelbase, turning radius, length, etc., may occasionally need special attention. As an example: a community having many narrow winding streets must have apparatus capable of readily negotiating switchbacks without delay.

Where fire apparatus may have to operate off paved roads, all wheel drive, a 2-speed rear axle, an auxiliary transmission or an automatic transmission, or combination of these may be desirable.

A-2-2.4 Training of specified fire department personnel is essential to ensure that the purchaser and user are aware of, and instructed in, the proper operation, care, and maintenance of the apparatus acquired. This training is intended to provide initial instruction to the trainees on the newly delivered apparatus. The training typically includes three (3) days of instruction in the user's community by a qualified representative of the contractor. An

equivalent arrangement for furnishing the training, including the location where it is provided, its duration, and the provision of suitable training aids such as video tapes or training manuals, may be specified by the purchaser.

A-2-3.1.1 The power generated by internal combustion engines may decrease with an increase in altitude. The loss varies with the type of engine, the fuel it uses, and the amount of air inlet supercharging.

A-2-3.1.2 Although the purchaser must specify grades in excess of 6 percent, the occasional exposure to excessive grades is different than if it were an everyday occurrence. A combination of steep grades and narrow, winding roads may require prior consultation with manufacturers and then the designation of special road tests. If apparatus will be subjected to a class of service not normally encountered, a manufacturer cannot be expected to anticipate need without sufficient specification details.

A-2-3.2 The ability to accelerate from 15 mph to 35 mph (24 to 56 kpmh) is an important safety feature in cases where it is necessary to slow down at street intersections and quickly regain speed without shifting gears.

A-2-3.2(c) Although this standard recognizes the need for the vehicle to be able to accelerate to high speed, caution should be taken as to how fast the vehicle will travel. Consideration should be given to limiting the maximum speed the vehicle can obtain for safety.

A-3-1 The carrying capacity of a vehicle is one of the least understood features of design and one of the most important. All vehicles are designed for "rated GVWR" or maximum total weight, which should not be exceeded by the apparatus manufacturer or by the purchaser after the vehicle has been in service. For tractor-drawn vehicles, the design should be adequate for "rated GCWR" weight. There are many factors that make up the rated GVWR, including the design of the springs or suspension system, the rated axle capacity, the rated tire loading, and the distribution of the weight between the front and rear wheels.

One of the most critical factors is the size of the water tank; as water weighs approximately 8⅓ lb per gal, a 500-gal (1900-L) water tank will mean an additional weight of about 2 tons on the vehicle. A value of 10 lb per gal may be used when estimating the weight of the tank and its water, making about 2½ tons for a 500-gal (1900-L) tank.

The distribution of the weight between the front and rear wheels is also a factor for major consideration as improper design will seriously affect the handling characteristics. Too little weight on the front wheels may cause a front-end skid and, over bumpy roads, may cause the front of the vehicle to veer from side to side; at the very least it will be difficult to keep the vehicle under control. Too much weight on the front wheels will reduce the traction of the rear wheels and may result in a rear-end skid or difficulty in traveling over unpaved roads or in mud. Further, overloading of either front or rear wheels might require that the tires be of different sizes.

Overloading the vehicle by the manufacturer through design, or by the purchaser through specifying a small chassis with a large water tank, or by the purchaser adding a great deal of equipment after the vehicle is in service will materially reduce the life of the vehicle and will undoubtedly result in increased maintenance costs, particularly with respect to transmissions, clutches, and brakes. Overloading may also seriously affect handling characteristics, making steering particularly difficult.

Fire apparatus must be able to perform its intended service under adverse conditions that may require operation off paved streets or roads. Chassis components should be selected with the rigors of service in mind. It is not good practice to employ underrated frames, axles, or transmission even though the finished vehicle may be able to pass the road tests under favorable conditions.

A-3-1.1 A weight of 250 lb (114 kg) for a fully equipped fire fighter is used elsewhere in NFPA standards. The 200 lb (91 kg) per person used here does not include the weight of SCBA and tools carried by a fire fighter, as the weight of this equipment is accounted for elsewhere.

A-3-2.1 The standard does not contain any minimum for size of engine as the size of the engine must be chosen to correspond with the conditions of design and service.

Many fire departments have favored high torque low-speed engines for fire department service because such engines have good performance characteristics both when powering the apparatus through city traffic and when driving the pump. However, high-speed engines are frequently employed for fire apparatus, particularly in the case of commercial truck chassis. Where high-speed gasoline engines are selected for use in fire apparatus that may have to operate off paved highways, it is recommended that one of the following components be specified: 2-speed rear axle with high numerical ratio in low range or an auxiliary transmission.

A-3-2.1.1 The maximum no-load governed speed is established by the engine manufacturer as a safe limit of engine speed. The governor will prevent the engine from exceeding the safe speed. Most engine manufacturers allow a plus tolerance of 2 percent for maximum no-load governed speed.

A-3-2.1.3 Automatic fuel line safety shutoff as required by DOT regulations is not considered an automatic engine shutdown.

A-3-2.2.1 Where a regular production model commercial chassis is used, it is recommended that the heavy-duty radiator option be included when such is available. Radiators with bolted top and bottom tanks and removable side braces, if available, are considered preferable. Optional features that may be desirable include a coolant conditioner, which should be of a type approved by the engine manufacturer, radiator sight gauges, and automatic radiator shutters.

Where local environmental extremes exist, i.e., high humidity and temperature or extreme low temperatures, the purchaser should specifically state under what environmental conditions the apparatus is expected to operate.

A-3-2.3.1 Full flow oil filters are mandatory with some diesel engines.

A-3-2.4.1 A manual emergency engine shutdown may be provided, in addition to the normal engine shutoff switch. It may be of the type that will close off either the air supply or the exhaust gas flow of the engine. The activation mechanism should be provided with a guard and marked "Emergency Shutdown." Provisions to prevent restarting of the engine without a special reset procedure should be included.

A-3-2.4.1.2 To prevent engine shutdown due to fuel contamination, dual filters in parallel, with proper valving so that each filter can be used separately, may be desired. The purchaser should specify if dual filters are desired. Installation of 2 or more pumps should be designed so that failure of 1 pump will not nullify the performance of the others. It should be remembered that commercial trucks are designed for over-the-road operation, and the fuel system and battery are at least partially cooled by the flow of air resulting from the motion.

A-3-2.4.1.3 With the use of diesel engines the concern for vapor lock common with gasoline engines does not exist, and electric fuel pumps are not usually compatible for connection in series with a diesel engine fuel system. As a result when an electric fuel pump is specified with a diesel engine it is arranged as a fuel priming pump only. When not properly labeled or when the control valves are not properly set, the auxiliary priming system can cause the diesel engine to lose its prime. In addition, operation of a priming pump during diesel engine operation may boost fuel inlet pressure to the engine's fuel system. This may cause erratic engine behavior and loss of engine speed control. Control systems for priming pumps should allow only momentary operation and prevent the operation of the pump while the engine is operating.

A-3-2.5 Emissions from exhaust discharge pipes should be directed away from any fire fighting tools since such emissions contain an oily substance that could make the tools difficult to handle and possibly dangerous to use.

A-3-3.1.3 It is not the intent of this requirement that electrical devices not manufactured by the apparatus manufacturer, but mounted on the apparatus by the apparatus manufacturer, be rewired to meet this requirement. Electrical device manufacturer supplied wiring can be used to the point where it connects to apparatus manufacturer's installed wiring.

A-3-3.2.1 An alternator is normally the permanent source of electric power on fire apparatus. Alternators produce 12 volt dc current at speeds of 800 to 1600 rpm.

Problems develop when the purchaser specifies electrical equipment, such as emergency lighting and flood lighting, that draws large amounts of current that may be beyond the alternator's capacity. Automatic throttle devices may be installed that increase engine speed when the apparatus is parked and allow higher levels of power production by the alternator. When installed, automatic throttles should be provided with interlocks that prevent their activation when the pump is engaged, when the apparatus is in any gear other than park or neutral, and when the vehicle's parking brakes have not been engaged.

When voltages other than 12 volts are desired, transformers must be specified. When transformers are utilized, the appliances driven by the current from the transformer should be equipped with a rectifier, or the transformer should be provided with a rectifier to prevent the burnout of electric motors.

Another method of producing 120 volt power is through the use of a power inverter that produces 120 volt ac current at a constant frequency of 60 Hz. Power inverters take power directly from the alternator at a higher voltage or directly from the battery system.

A-3-3.3.1 Overheating of a battery will cause rapid deterioration and early failure; evaporation of the water in the battery electrolyte may also be expected. Batteries in commercial truck chassis are often installed to take advantage of the cooling effect of the flow of air from motion in over-the-road operation and may be subject to overheating when the vehicle is stationary, such as during pumping operations.

The battery capacity is a very important and frequently overlooked factor in vehicle performance. A fire apparatus needs a much higher capacity battery than does a commercial truck because of the large number of lights and other power-consuming devices. Where a radio, a large siren, various flashing or rotating lights, spotlights, electric hose reels, and other power-consuming devices are installed, the total current needed for short periods may be more than that provided by an alternator, particularly with the engine idling, and the battery must be of ample size to carry the load.

Early lead acid storage batteries served mainly as a source of power for small electric lights, signals, and other low current electrical equipment. The amp-hr capacity at the 20-hr rate was a significant measure of the battery's ability to perform this function. Today, with modern charging systems, the battery is no longer called upon to perform this function, except in rare emergencies.

The prime function of the battery in modern vehicles is to furnish sufficient power to crank the engine. The Society of Automotive Engineers (SAE) recognized the change of the prime function of the battery in the vehicle and developed a new rating system to enable the user to specify a battery that would meet the cranking requirements of the engine.

A new "cold cranking test" has been established that specifies the minimum amperes available at 0°F (–18°C) and –20°F (–28°C) for cranking. This rating specifies the amperes the battery will deliver for 30 sec with a minimum voltage of 1.2 volts per cell. The 1.2 volts per cell requirement for new, fully charged batteries represents the voltage required for cranking the vehicle. Thirty sec represents the maximum cranking time for an engine in an acceptable state of tune.

With engine manufacturers specifying the cold cranking amperes for satisfactory cold cranking performance, the user can specify the proper capacity battery for the application. By basing the specification on the old 20-hr rate, the customer could get a battery with good or poor cold cranking performance. The new rating system ensures that the customer will get the performance specified.

Batteries also have a "reserve capacity rating" that represents the approximate time in minutes it is possible to travel at night with an inoperative alternator and minimum electrical load. This rating, in minutes, is the time required to discharge a fully charged battery at 25 amp at 80°F (27°C) to a terminal voltage of 1.7 volts per cell (10.2 volts for a 12-volt battery).

A-3-3.3.3 The purchaser may want to consider a second "battery on" pilot light on the outside of the vehicle to warn that the batteries are on when the apparatus is parked in the fire station.

A-3-3.3.4 With the adoption of diesel engines for use in fire apparatus, the traditional dual battery system that had previously been developed for use with gasoline engines was modified to provide only a partial dual system. Because the diesel engine required much greater cranking effort, it became common practice in the industry to connect the starter switches in parallel thereby using both battery systems for engine cranking. Together, both batteries or battery systems met the engine manufacturer's recommendations for minimum battery size, but neither system alone would crank the engine when the engine was either up to operating temperature or below 45°F (7°C) for any period of time.

The dual battery system is further complicated by the fact that it requires regular switching to maintain a full charge in each battery system. Although the partial system provides some ability to operate lights and accessories, if one system should fail or lose its charge, the modified dual system does not provide the ability to start or restart the diesel engine under many circumstances.

A truly functional dual battery system for larger engines will necessitate the storage of batteries in additional compartments normally used for fire fighting equipment. A single battery system arranged in accordance with the engine manufacturer's recommendations will provide the user with the most reliable vehicle electrical system. Maintenance of the system is simplified, and numerous components and circuits associated with dual systems are eliminated.

A-3-3.5.1 The purchaser should strongly consider the use of a combination of red and blue warning lights where such combinations are permitted by state or local law. With lights of equal intensity, red is more effective in the daylight, and blue is more effective at night.

A-3-3.5.3 In some vehicles, multiple control switches may be necessary to achieve convenient reach from the 2 positions.

A-3-3.5.6 Special attention should be given to the proper illumination of the pump operator's panel.

A-3-4.1 Auxiliary braking devices such as transmission retarders and exhaust restriction devices should be disconnected when the apparatus is operated on slippery surfaces. These devices may cause skids on these surfaces.

A-3-4.1.1 It is required that service and parking brakes be independent and separate systems so that any failure of one braking system will not prevent stoppage of the vehicle through use of the other system. Installation of a device that locks in the hydraulic pressure on the service brake system does not constitute a parking brake, nor does a "park" position on an automatic transmission.

A-3-4.1.3 Adequate braking capacity is essential for the safe operation of fire apparatus. While this subject is normally covered in state highway regulations, it should be noted that fire apparatus may have a special problem as compared with normal trucks of the same gross vehicle weight. Fire apparatus may be required to make successive brake applications in a short period of time when attempting to respond to alarms with minimum loss of time. Thus, the problem of brake "fade" and braking capacity may be critical unless the brakes provided take into account the service requirements. Air actuated brakes are recommended for fire service vehicles of over 25,000 lb (11350 kg) GVWR. Where air brakes are provided, it is important that they be of quick buildup type with dual tanks and a pressure regulating valve and that the rated compressor capacity be not less than 12 cu ft (.34 m^3) per min for this class of service. Also, air brakes require attention to guard against condensation in the air lines such as may occur in certain areas subject to marked seasonal changes in climate affecting the moisture content of the air. Air pressure drop should be limited to normal air losses. Presence of the following condition indicates the need for immediate service:

1. Air brake pressure drop of more than 2 psi (13.8 kPa) in 1 min for single vehicles or more than 3 psi (20.7 kPa) in 1 min for vehicle combinations, with engine stopped and service brakes released.

2. Air pressure drop of more than 3 psi (20.7 kPa) in 1 min for single vehicles or more than 4 psi (27.6 kPa) in 1 min for vehicle combinations, with engine stopped and service brakes fully applied.

A-3-4.2.3 The angle of approach or departure affects the road clearance of the vehicle when going over short steep grades such as would be found in a driveway entrance, crossing a high crowned road at right angles, or in off-road service. Too low an angle of approach or departure will result in scraping the apparatus body. In those cases where equipment is stored below the body, the angle of approach or departure must be measured to a line below the equipment.

A-3-4.2.4 In areas where tire chains are to be used, additional clearance should be specified. Single chains for outside dual rear wheels are recommended.

A-3-4.3 Where automatic transmissions are used, the power takeoff applications may present problems, especially when dual PTO drives are required. In some instances, the PTO drive can only be engaged in torque converter range with resultant chances of overheating with prolonged use. If high engine rpm occurs, there is the possibility, if the truck is accidentally left in gear, of the output torque overcoming the parking brake and moving the vehicle. Proper operational instructions are essential with automatic transmissions.

A-3-4.4.1 When a large capacity fuel tank is desired, as in the case of apparatus designed for rural service, the capacity should be specified by the purchaser.

A-3-4.4.2 It is not a recommended practice to add a second tank to a commercial vehicle where the original tank is too small, since such tanks are seldom designed for dual tank use. Where large fuel capacity is required, over 50 gal (189 L), dual tanks designed for the purpose are acceptable. In such circumstances, it is undesirable for a pump operator to be required to open or close valves manually to provide additional fuel supply to the engine, and, further, there should be a free flow from both tanks so that fuel will not remain unused in any tank for long periods. The tanks should be arranged with check valves in the line with free flow to a mutual feed line. Unfortunate incidents have occurred where operators have used the fuel in one tank, switched to another tank, and neglected to refill the first tank on return to the station. It is also desirable that the fuel gauge be so installed that the operator can immediately determine the amount of fuel still remaining in the fuel system without mental addition of various fuel tank capacities.

A-3-4.5 If the purchaser wants the hooks or rings to be accessible without having to open compartment doors, the specifications should specifically state that fact.

A-3-4.7 The purchaser should consider specifying remote controls on the mirrors to facilitate correct mirror adjustment. Where necessary, heated mirrors should also be considered.

A-3-4.7.2 Canopy cab extensions with patio door-type closures or separate telephone booth-type personnel enclosures are acceptable means to accomplish this safety design feature. The use of 3-point seat belts, where available, is encouraged.

A-3-4.7.7 SCBA units and other equipment stored in the crew compartment may cause injuries to occupants of the compartment if they fly around the compartment as the result of an accident. All equipment stored within the crew compartment should be provided with brackets or compartments to minimize the chance of injury.

A-4-1.1 A midship pump location is most common although front mounted or rear mounted pump locations are available.

For the department buying its first pumper, a unit rated at not less than 1000 gpm (3785 L/min) is recommended. This will permit water delivery in greater quantity to master stream appliances and long hose lays.

A-4-1.2.2 Parallel operation may be referred to as "volume," and series operation may be referred to as "pressure."

A-4-1.3.2 Where the community to which the apparatus is to be delivered is at a considerably higher altitude than the factory or other test location, sufficient excess power must be provided to compensate for the fact that the power of a naturally aspirated internal combustion engine decreases with elevation above sea level.

Where elevation exceeds 2000 ft (610 m) above sea level, or suction lifts exceed 10 ft (3 m), or more than 20 ft (6 m) of suction hose is used, or where the purchaser desires to pump the rated capacity from one side of the apparatus only, the purchaser must so specify.

A-4-3.1 Pumps and piping frequently required to pump salt water or other corrosive waters should be bronze. For occasional pumping of such water, iron pumps, bronze fitted, are satisfactory if properly flushed out by fresh water after such use.

The term "all bronze" indicates that the pump main casing, impellers, intake and discharge manifolds, and other principal components exposed to the water to be pumped, with the exception of the shaft, bearings, and seals, are of a high-copper alloy material.

Corrosion effects are proportional to the mass relationship of bronze to iron. It is, therefore, desirable to use like materials for the pump and piping, and where both iron and bronze are used, to keep the mass of the iron larger than that of the bronze.

While all pumps of the same rated capacity must meet the same performance standards, there are sometimes reasons why a fire department prefers a particular type. In such cases, the type of pump should be indicated. Some prefer a single stage pump. Others like a multiple stage pump. Any such preference should be indicated with due regard to engine and transmission characteristics.

A-4-4.1 Intakes may be larger than the size of the suction hose specified in Table 4-1.3.1(a). When a larger size is desired, it should be specified by the purchaser.

A-4-4.3 Two or more auxiliary 2½-in. (65-mm) gated intakes, or a suction siamese of the proper size to permit attachment to a gated large intake, are desirable. A suction siamese attached to a large suction inlet will usually permit greater flow than two or more auxiliary 2½-in. (65-mm) inlets when the water supply pressure is marginal.

A-4-4.3.1 It may be desirable to have one or more of the intakes gated. If this is desired, the purchaser should specify which inlets are to be gated.

Intakes at the front or rear of the apparatus, or otherwise specially situated, may not permit drafting rated capacity and pressure. The purchaser should specify the flow rates required from auxiliary intakes, especially front and rear intakes.

A-4-5 An intake relief valve will relieve excess suction pressure, but some water hammer conditions may occur so quickly that the relief valve cannot respond fast enough to eliminate damage to equipment. Proper fire ground procedures are still required.

A-4-5.4 To reduce the potential for failure to establish a prime, it may be desirable to install a check valve down stream of the intake relief valve. This valve should be installed to permit flow only from the intake to atmosphere. The check valve flow area should be equal to, or larger than, the flow area of the relief valve. Under no circumstances should a manually controlled valve be installed that may be used to manually disable the operation of the relief valve.

A-4-6.1 This standard provides for a minimum flow of 500 gpm (1900 L/min) from the water tank. This is to permit the supplying of two 1½-in. (38-mm) or 1¾-in. (44-mm) hose lines or one 2½-in. (65-mm) hose line or a

preconnected deck gun from the tank for an initial attack on the fire. Fire departments that desire to discharge water from tanks at a rate greater than 500 gpm (1900 L/min) should specify the greater rate of flow.

A-4-6.2 A check valve installed in the tank to pump line is the most common method used to prevent water from flowing into the tank at an excessive rate if the pump is being supplied from a hydrant or relay pumper and the tank to pump line valve has been inadvertently left in the open position. An excessive flow rate when filling tank may result in a pressure buildup in the tank that will cause permanent damage or failure.

A-4-7.1 The flows listed for each outlet size are minimum and are for rating purposes only. If piping and valving are sufficient, much higher flows for a given outlet size may be achievable.

A-4-7.2 If flows greater than 200 gpm (757 L/min) through preconnected lines are desired, piping from the pump to preconnect hose lines should be larger than 2 in. (51 mm) in order to keep the friction loss to a reasonable level.

A-4-7.7 Where possible, discharge outlets should be positioned in an area away from the normal pump operator's position.

A-4-7.8 It is necessary to design the tank for adequate venting and overflow for the maximum fill rate. A locking-type ball valve, globe valve, needle valve, or other type suitable for throttling service should be used. A gate valve is not recommended. If a larger fill line is desired, the buyer should consult with the manufacturer on construction of the tank inlet location and any required reinforcement or alternation of the tank baffles.

A-4-9.3 Many fire departments have found it useful to color code the labels used to identify the various discharge and intake controls. While this process can simplify pump operations, it can also create confusion if a pattern is not followed on all apparatus in the department. For standardization, the following color coding scheme is recommended for all new apparatus labels.

Preconnect #1 or Front Bumper Jump Line	Orange (see note)
Preconnect #2	Red (see note)
Preconnect or Discharge #3	Yellow (see note)
Preconnect or Discharge #4	White (see note)
Discharge #5	Blue
Discharge #6	Black
Discharge #7	Green
Deluge/Deck Gun	Silver
Water Tower	Purple
Large Diameter Hose	Yellow with White Border
Foam Line(s)	Red with White Border
Booster Reel(s)	Grey
Inlets	Burgundy

NOTE: Since the vast majority of fires are extinguished using preconnected lines, a fire department should give consideration to matching the hose jacket color to the color of these labels. Fire departments using this system have reported that an improvement in fire ground operations was achieved.

A-4-10.2 Pumpers are operated from the side, top, front, or rear of the vehicle, and the design is such that there is no power applied to the wheels while pumping. Dislocation, through vibration or accidental jarring, of any levers used to prevent power from being applied to the wheels could result in a serious accident. Therefore it is essential that any pumping system controls, which shift the vehicle out of road mode of operation to place the pumping system into operation, be equipped with a means to prevent dislocation of the control.

A-4-10.8 Positive pump intake pressures may affect relief valve performance. A pump panel label indicating this condition should be provided.

A-4-11 When a pressure governor is provided and is set to control pump pressure, and is in the "on" position, engine speed is controlled by the governor, and the hand throttle may be inactivated.

A-5-2.1 Tanks should be capable of being completely cleaned out. The purchaser should indicate in the specifications whether a removable tank lid is required.

A-5-2.4 The design of a water tank can be a very critical factor in the handling characteristics of fire apparatus. If water is free to travel either longitudinally or horizontally in a tank, as would be the case if the tank were half full, a tremendous amount of inertia can be built up that will tend to force the vehicle in the direction the water has been traveling. When the water reaches the end of the tank this sudden application of force can throw the vehicle out of control and has been known to cause fire apparatus to turn over or skid when going around a curve or coming to a sudden stop. The only method of preventing such an accident is to impede the motion of the water so that the inertia will not build up; this is done through the installation of swash partitions so designed that the water is contained in small spaces within the tank. These spaces are interconnected by openings at the top and bottom so that air and water can flow between compartments at the desired rate when filling and emptying the tank.

A-5-3.2 An overflow outlet is necessary so that unwanted pressure does not occur within the tank when filling it. However, water is likely to spill out of the overflow while the vehicle is moving, going around a curve, accelerating, or decelerating. Therefore, it is essential that the overflow outlet be so arranged that water is not spilled in front of the rear tires where it could cause a skid or loss of traction. Although the fill opening is 20 sq in. (12900 mm^2), experience indicates a need for additional air release other than through the fill opening for most designs. The total opening of all venting/overflow should be at least 4 times the cross-sectional area of the sum of all tank fill connections. The primary vent may be the overflow connection, and it should have an opening of not less than 12 sq in. (7742 mm^2). Additional venting may be provided by the covered fill opening that is free to lift by the flow of air and water. Where filling may be done on sloped terrain, tank top corner venting should be added.

A-5-3.3 Additional methods may be desired to improve the off-loading rate of gravity dumps. These include a jet assist or a pneumatic pump. Control should be from the pump operator's position. Two types of jet assist can be used, one directed into the throat of the gravity dump and the other a peripheral jet system. Figure A-5-3.3(a) shows how the traditional jet is installed. A smooth tipped "jet" nozzle is supplied by a pump capable of delivering at least 250 gpm (946 L/min) at 150 psi (1034 kPa). Nozzle jets range in size from 3/4 in. (19 mm) to 1 1/4 in. (33 mm). The diameter of the tip will be determined by the capacity of the pump being used and the diameter of the discharge piping and dump valve.

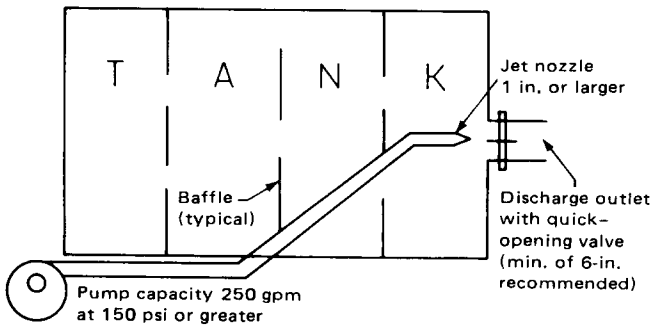

Figure A-5-3.3(a) Traditional Internal Jet Dump.

The peripheral application of jet assist nozzles has proven highly effective. This approach utilizes 2 or more jets installed in the sides of the discharge piping just outside the quick dump valve. In addition to the reported discharge advantages of peripheral discharge streams, the externally fed system is easier to plumb and has fewer maintenance problems. The jets, installed 25 to 30 degrees from the piping wall, contact more surface area of the discharging water, thereby increasing water discharge efficiency. Because the water is drawn through the dump valve, less turbulence is created and the eddy effect often present with traditional in-line jets is overcome. Nozzles made by welding reducer pipe fittings work very effectively as jets. Two thousand-gpm (7570-L/min) flow rates have been obtained using a 300-gpm (1136-L/min) pump to supply two 3/4-in. (19-mm) nozzles in a 6-in. (152-mm) dump valve configuration.

A pneumatic system can be used to pressurize a tank and assist in expelling water. The vacuum pumps can also be used for filling the tank.

A-5-3.4 Where large filling rates are used, fill connections should be equipped with a diffuser inside the tank to minimize potential structural damage.

A-6-1.1 Additional compartmentation may be required to accommodate the size, shape, and weight of special equipment. Any special equipment to be carried on the apparatus should be identified in the specifications so the apparatus manufacturer can ensure the equipment will be properly accommodated within the design of the apparatus.

A-6-2.1 It should be recognized that pumpers of 1000 gpm (3785 L/min) rated capacity or more normally require more than 1200 ft (366 m) of 2 1/2-in. (65-mm) hose to utilize their pumping capacity and their 2 1/2-in. (65-mm) (or larger) discharge connections. For example, the 1200-ft (366-m) load provides only 300-ft (91-m) lines from the four outlets of a 1000-gpm (3785-L/min) pumper and less than an average of 250 ft (76 m) per line with a 1250-gpm (4732-L/min) pumper. Experience has shown that, with large capacity pumpers, 1800 to 2000 ft (550 to 610 m) of hose may be desirable, except where separate hose trucks are provided, to utilize available pumping capacity. Additional hose capacity may also be desirable for 750-gpm (2850-L/min) pumpers. An 1800-ft (550-m) load will provide three 600-ft (183-m) lines or two 900-ft (275-m) lines that are well within the normal performance of this size of pump.

Fire departments serving areas with wide hydrant spacing and nonhydranted areas often find it desirable to have additional space for hose. Even though pump capacities may only be in the 750 gpm (2850 L/min) range, 2 1/2-in. (65-mm) hose bed capacity up to 2000 ft (610 m) may be beneficial. If scattered suction sources are available to pumpers, hose bed capacity for quantities of 3-in. (76-mm) or larger hose would enable a fire department to lay its own "water main."

The purchaser should consider specifying some type of cover for the hose compartment. Hinged or removable covers may be desirable.

A-6-3.1 Corrosion protection, commonly known as undercoating, may be desired in areas where climatic conditions or road treatment will corrode vehicle components. The material, its application method, and the areas to be protected should be carefully specified so the corrosion protection will adequately protect the vehicle's cab and body sheet metal components subject to corrosive conditions that could be encountered in user's area.

The purchaser should give consideration to the choice of paint color(s) as it relates to the total vehicle conspicuity system.

A-7-1.1 Where there are no ladder trucks in service, pumpers should normally be equipped with a 35-ft (10.7-m) extension ladder instead of the minimum 24-ft (7.3-m) extension ladder. It may be desirable to standardize on the 35-ft (10.7-m) extension ladder irrespective of available ladder truck service.

A-7-1.2 The size of the suction hose specified in 4-1.3.1 relates to pump certification only. Other sizes of suction hose, compatible with local operations, may be specified.

A-7-2 The requirements of service in different communities will necessitate variations from the equipment suggested. While it is recommended that the lists be considered as a minimum, due regard must be given to other highly specialized or multipurpose apparatus and auxiliary apparatus in service. The operational objective is to arrive at the scene of the emergency with the necessary equipment for immediate life safety operations and emergency control. The purchaser should consult with the fire insurance rating organization having jurisdiction before completing apparatus specifications.

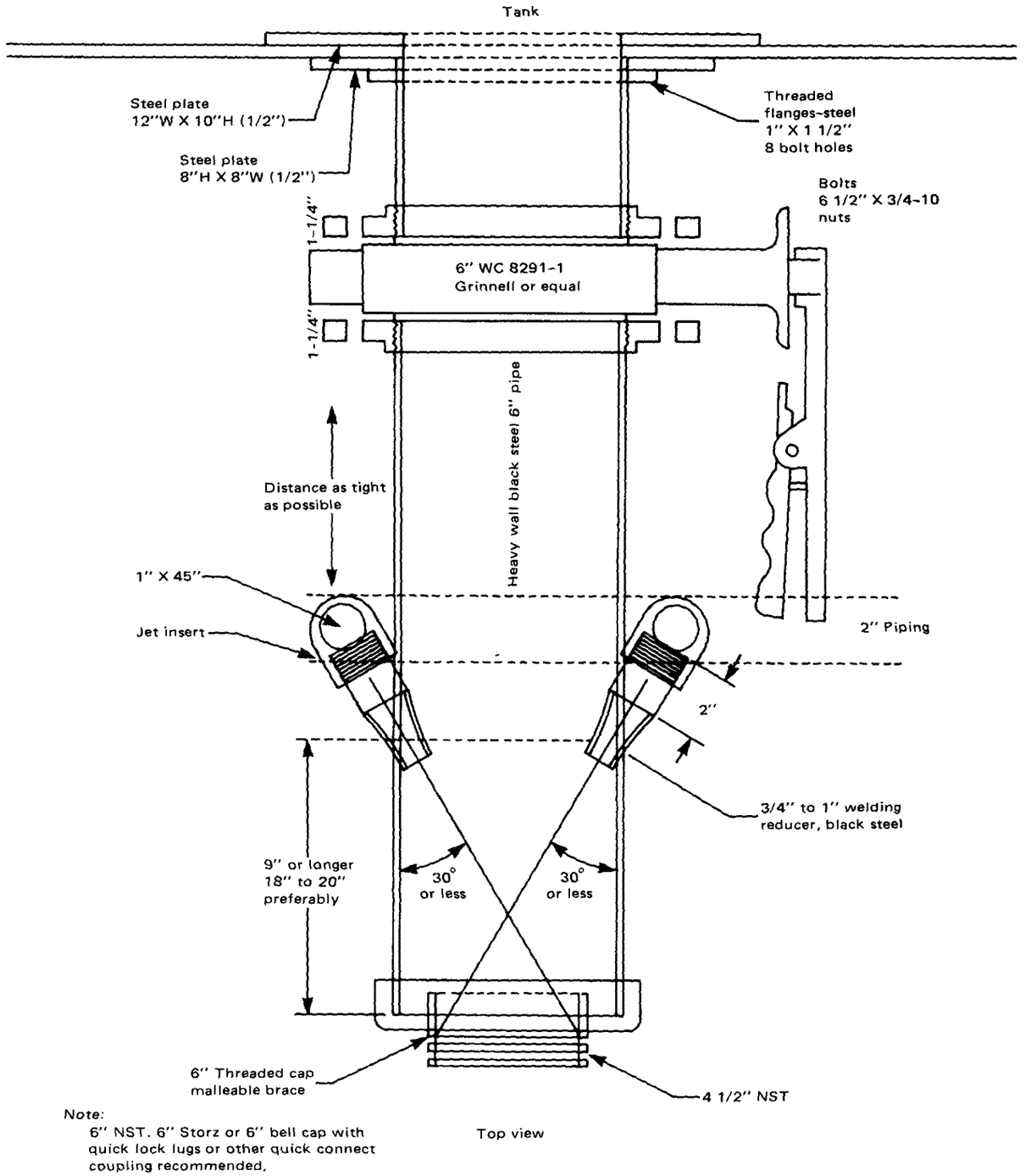

Figure A-5-3.3(b) Peripheral Jet Assist Arrangement.

The following list of additional equipment is recommended to be carried on pumpers:

One fire service claw tool.

One 16-in. (406-mm) or larger (5000-cfm or larger) smoke ejector. If electrically driven, suitable adapter cord shall be supplied to fit standard house "U" ground outlets and extension cords and outlets on generators used in fire departments.

One crowbar [36 in. (1 m) minimum] with brackets.

One pair, insulated bolt cutters with 7/16-in. (11-mm) minimum cut.

One Halligan-type tool with brackets.

One 2 1/2-in. (65-mm) hydrant valve (screw-type gate).

Two shovels (1 pointed and 1 scoop).

Four hose straps.

One 125-ft (38-m) utility rope (not for lifeline work).

One 3000-watt (minimum) portable generator.

Two 500-watt portable lights.

Two cord reels with minimum 200-ft (61-m) cord on each, connections compatible with lights, generator, and smoke ejector.

Two metal containers, minimum 5-gal (19-L) capacity.

One portable pump.

Toolbox with hammers, wrenches, screwdrivers, and other assorted tools.

Master stream appliance; 1000 gpm (3785 L/min) minimum.

Foam delivery equipment compatible with onboard foam system.

One hose clamp.

If personnel alert safety systems (PASS) devices are not provided to each fire fighter, sufficient devices should be provided on the apparatus to accommodate each fire fighter riding on the apparatus. PASS devices should meet the requirements of NFPA 1982, *Personal Alert Safety Systems (PASS) for Fire Fighters*.

A-8-1.1 The types of operation for an auxiliary pump are:

1. Simultaneous auxiliary pump and main pump performance from draft.
2. Auxiliary pump stationary performance, from draft.
3. Auxiliary pump performance at a given vehicle speed.
4. Auxiliary pump stationary performance from booster tank.

Auxiliary pumps that are predominantly for fighting grass fires, or other small blazes, usually supply one or two reels of 1-in. (25-mm) booster hose, and a capacity of up to 60 gpm (227 L/min) at pressures not exceeding 800 psi (5516 kPa) is adequate. When one or two lines of 1 1/2-in. (38-mm) hose are to be supplied, a capacity of 250 gpm (950 L/min) at 150 psi (1035 kPa) is desirable. If larger fire streams are to be supplied through 2 1/2-in. (65-mm) hose, a capacity of 250 gpm (950 L/min) or more at 150 psi (1035 kPa) will be needed. When working pressures exceeding 250 psi (1725 kPa) (high pressure) are to be used, the pump capacity should be 50-60 gpm (190-227 L/min) at the specified pressure.

One of the following ratings is suggested:

500 gpm at 150 psi	(1900 L/min at 1035 kPa)
250 gpm at 150 psi	(950 L/min at 1035 kPa)
100 gpm at 250 psi	(379 L/min at 1724 kPa)
50-60 gpm at 600-800 psi	(190-227 L/min at 4137-5516 kPa)

A-8-1.2.1 Various types of pump drive systems are available. These pumps are often driven by power takeoff units attached to SAE 6-bolt openings on the chassis transmission. There are also 8-bolt PTO systems, front of engine PTO systems, flywheel PTO systems, split driveline PTO systems, and separate engine drive systems.

A-8-1.2.2 The volume and pressure that can be obtained safely depends on the torque capacity of the truck's transmission or transfer case, power takeoff, and pump driveline. In most cases, the torque rating of the PTO will determine maximum pump performance. Power takeoff manufacturers assign a torque rating to their products. This torque rating is based on intermittent service, as in operating the PTO at the full torque limit for a period of 5 min or less. For continuous duty the intermittent torque rating is devalued 30 percent.

A-8-1.2.3 Sustained operations at either high volume, or high pressure, or both high volume and high pressure may cause excessive heating of the transmission lubricant. In order to maintain lubricant temperatures below manufacturer's published limits it may be necessary to employ oil-to-oil or oil-to-water heat exchangers. The latter should be of a type in which water will not be trapped and cause serious damage if subsequently frozen.

A-8-1.3.1 Auxiliary pumps come in a variety of different styles; gear, piston, and centrifugal designs are available. When centrifugal designs are specified the purchaser also has to select if it is to be a single stage, series only multistage, or series/parallel multistage-type pump.

A-8-1.4.1 The purchaser should indicate the number, size, and location of the pump intake connections or combination of connections desired. The types of pump intake connections are:

(a) External intake.
(b) Direct supply line from booster tank.
(c) Supply line from discharge side of fire pump.

A-8-1.5 The purchaser should indicate the size, number, and location of the pump discharge connections desired. The types of pump discharge connections are as follows:

(a) Discharge line(s) for nonpreconnected hose lines.
(b) Discharge line(s) to preconnected hose lines.
(c) Discharge line(s) to booster reel(s) (if provided).

A-8-1.5.3 In order to provide standardization, National Standard hose threads should be provided and adapters, if required, made to adapt to the National Standard hose threads.

A-8-2 Line voltage (120, 120/240, or 240 volt) electrical systems are the combination of several distinct subsystems. First, there is a power source (*see Fig. A-8-2*). This device

produces the line voltage power. The power is then sent to a distribution panelboard that distributes the power through overcurrent devices to wiring systems. Loads that may be either permanently mounted or portable are then connected to the system through either receptacles or switches.

Portable generators combine the power source, distribution panelboard, overcurrent devices, wiring systems, and receptacles into one piece of equipment. (*See Fig. A-8-2.*)

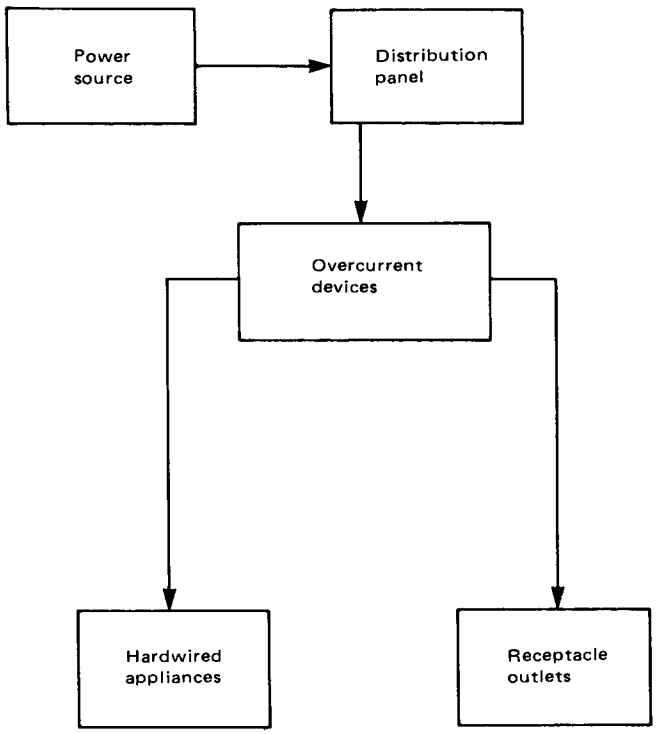

Figure A-8-2 Schematic of Line Voltage Electrical System.

A-8-2.2.1(e) The system should be sized based on the total amount of fixed and portable equipment that is likely to be operated at the same time.

A-8-2.2.5 In view of the increasing use of line voltage devices on apparatus, the provision of a line voltage electrical system of sufficient capacity is strongly recommended. Where line voltage equipment use is extensive, a separately driven generator is recommended.

Where only incandescent lighting is involved, ac or dc power may be used. Where other electrical devices such as motor driven equipment or electronic equipment are involved, single phase ac power at 60 cycles is normally required. However, because of the substantial reduction of size and cost that results from 3-phase operation, ac motors larger than one horsepower are usually designed to operate on 3-phase ac current.

Attempting to operate electrical equipment using the wrong type of electrical power will almost always damage electrical equipment.

The most common types of line voltage power sources are as follows:

(a) *Gasoline Powered Generator.* A separate engine driven device very commonly used on fire apparatus.

(b) *Diesel Powered Generator.* A separate engine driven device very commonly used for fire apparatus.

(c) *Hydraulic Powered Generator.* The vehicle propulsion engine is used to drive a hydraulic pump, which in turn drives the hydraulic motor that powers the generator. Normally used to power larger generators, it is generally not used on pumping apparatus.

(d) *PTO Powered Generator or Fan Belt Driven Generator.* Also driven by the vehicle propulsion engine, the need to maintain a constant engine speed tends to make these arrangements unsuitable for pumping apparatus.

(e) *12/24 Volt (Low Voltage) Motor Powered Generator.* Powered directly from the vehicle's electrical system, these systems are limited by the alternator and battery set to about 1600 watts.

(f) *Transformer Connected to the Vehicle's 12/24 Volt Alternator.* The normal output of 120 volts dc is usable only for work lights, and, as above, the output wattage is limited by the alternator and battery set.

(g) *Converter/Inverter Connected to Vehicle's 12/24 Volt Alternator.* These devices are subject to the same output limitation as the transformer and dc motor driven systems, but they do produce alternating current suitable for operating motors as well as lights.

A-8-2.3.2 Ground-Fault Protection for Personnel. Because of the nonearth grounded nature of apparatus mounted line voltage equipment and the wet environment in which it operates, great care should be taken in the use and maintenance of such line voltage circuits and equipment. (*See NFPA 70B, Recommended Practice for Electrical Equipment Maintenance.*)

Ground fault protection for personnel should be furnished through an assured equipment grounding conductor program in accordance with Section 305-6(b) (Assured Equipment Grounding Conductor Program) of the NEC. All cord sets, receptacles, and electrical equipment should be maintained according to NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance.*

This protection can be supplemented by the use of portable Ground-Fault Circuit-Interrupters. These GFCI's should be attached to the end of distribution cords and located close enough to the point of operation so that they can be conveniently reset in the event of trips.

While this arrangement is desirable for fire service operating conditions and does protect fire fighters who are operating tools and lights downstream of the GFCI, it must be realized that no protection is provided between the source and the GFCI.

If premises wiring or other fixed wiring systems are to be powered by the generator, grounding of the system MUST comply with Section 250-5 of the NEC. If grounding rods, plates, clamps, or other means of bonding the vehicle and the source to an earth ground are desired, this equipment should be specified by the purchaser.

A-8-2.7.2 Locking-type plugs and receptacles are designed to prevent accidental disconnection when subjected to moderate pull apart loads. Neither locking or nonlocking connectors are designed to withstand the loads that can be created when pulling long cords up buildings and stairs.

A-8-3 It is necessary for the purchaser to understand the types and properties of mechanical foam and its application to properly specify a foam proportioning system. Specific information regarding foam concentrates and their application is available in NFPA 11, *Low Expansion Foam and Combined Agent Systems*.

A-8-3.1 Foams are also defined by expansion and arbitrarily subdivided into 3 ranges of expansion. These ranges correspond broadly to certain types of usage. The three ranges are: low expansion foam—expansion up to 20; medium expansion foam—expansion 20 - 200; high expansion foam—expansion 200 - 1000.

There are a number of foam concentrates available for use in the low expansion foam systems. These include:

(a) *Protein-Foam Concentrates* consist primarily of products from protein hydrolysate, plus stabilizing additives and inhibitors to protect against freezing, to prevent corrosion of equipment and containers, to resist bacterial decomposition, to control viscosity, and to otherwise ensure readiness for use under emergency conditions. They are diluted with water to form 3 percent to 6 percent solutions depending upon the type. These concentrates are compatible with certain dry chemicals.

(b) *Fluoroprotein-Foam Concentrates* are very similar to protein-foam concentrates as described above, but with a synthetic fluorinated surfactant additive. In addition to an air-excluding foam blanket, they may also deposit a vaporization preventing film on the surface of a liquid fuel. They are diluted with water to form 3 percent to 6 percent solutions depending on the type. These concentrates are compatible with certain dry chemicals.

(c) *Synthetic Foam Concentrates* are based on foaming agents other than hydrolyzed proteins. Aqueous Film Forming Foam (AFFF) concentrates are the most common and are based on fluorinated surfactants plus foam stabilizers. They are usually diluted with water to a 1 percent, 3 percent, or 6 percent solution. The foam formed acts both as a barrier to exclude air or oxygen and to develop an aqueous film on the fuel surface capable of suppressing the evolution of fuel vapors. The foam produced with AFFF concentrate is dry chemical compatible and thus is suitable for combined use with dry chemicals.

Other hydrocarbon surface active agents are listed as wetting agents or as foaming agents, or both. In general, their use is limited to portable nozzle foam application to spill fires.

(d) *Alcohol-Resistant Foam Concentrates* are used for fighting fires on water soluble materials and other fuels destructive to regular or AFFF foams, as well as fires involving hydrocarbons. There are two general types. One is based on water-soluble natural polymers, such as protein or fluoroprotein concentrates, and also contains alcohol insoluble materials that precipitate as an insoluble barrier in the bubble structure. The other is based on synthetic concentrates and contains a gelling agent that surrounds the foam bubbles and forms a protective raft on the surface of water soluble fuels; these foams may also have film-forming characteristics on hydrocarbon fuels. Alcohol-resistant foam concentrates are generally used in concentrations of 3 to 10 percent solutions depending on the nature of the hazard to be protected and the type of concentrate.

(e) *Fire Suppressant Foams (FSF)* are chemical products that combine with water to make a solution for extinguishing fires in Class A materials. They are used in low ratio amounts from 0.1 percent to 1.0 percent and aspirated by adding compressed air to the discharge piping or by using aspirating handline nozzles. These foam solutions are commonly used in handline applications or low volume apparatus mounted appliances.

A-8-3.2.1 In-line eductors are installed in the water pump discharge either as a portable device or as a permanently installed device. Water is forced through the eductor venturi by pump pressure creating a negative atmospheric pressure. Foam concentrate is forced by atmospheric pressure into the water stream at the design rate of the device. Fixed or variable rate proportioning devices are available. Eductors have the following limitations.

(a) They have a limited flow and pressure range. For practical fire fighting purposes these devices operate satisfactorily at rated pressure plus or minus 50 percent.

(b) By design, a nonrecoverable pressure drop of 30 percent or greater is required for an eductor to operate. The maximum recovered pressure, including friction loss and static head, is about 65 percent of the inlet pressure. For example, at an inlet pressure of 150 psi (1034 kPa), the back pressure on the discharge side of the eductor must be less than 100 psi (690 kPa) for proper proportioning. If the back pressure exceeds 100 psi (690 kPa) (i.e., by the addition of another length of hose) the eductor will fail to introduce any foam concentrate.

(c) The length and elevation of the pickup system is restricted.

(d) As a rule the discharge device flow must be matched to the rated flow of the eductor for efficient operation.

Eductors do have the following advantages:

(a) They are inexpensive.

(b) They require minimal maintenance.

(c) They are simple to operate.

(d) They require a minimum amount of space on the apparatus.

A-8-3.2.2 Self-educting master stream nozzles are mounted on the discharge side of the pump. These devices comprise a complete foam proportioning system, consisting of a foam concentrate proportioner and application device (nozzle). The advantages of this system are:

(a) Operator adjustable foam solution rates of 3 or 6 percent.

(b) Minimal pressure drop, approximately 1 percent to 2½ percent of inlet pressure.

(c) They are relatively inexpensive.

(d) They require minimal maintenance.

(e) They are simple to operate.

(f) They require a minimum amount of space on the apparatus.

A-8-3.2.3 An around-the-pump proportioning system operates with an eductor installed between the water pump discharge and intake. A small flow of water from the water pump discharge passes through the eductor, which creates a vacuum causing foam concentrate to be inducted and discharged into the pump intake. Around-the-pump systems are available with fixed or variable rate proportioning. Manual variable proportioning is accomplished by an operator controlled metering valve that corresponds to a calibrated rating chart. With this system the operator must determine flow in order to set the metering valve. Automatic variable proportioning systems rely on a flow meter monitoring system for total solution flow and foam concentrate flow. The flow data is fed into a microprocesser that provides readout and operator control of the foam solution percentage. Around-the-pump systems are relatively inexpensive, but they have the following limitations:

(a) Water pump intake pressure cannot exceed approximately 10 psi (69 kPa).

(b) Water and foam solution cannot be discharged simultaneously from the pump. Once activated, the system produces foam solution from all open pump discharge outlets.

(c) It is difficult to match foam concentrate with the performance desired.

(d) Internal components require frequent maintenance.

A-8-3.2.4 Premixed foam systems utilize a separate tank to contain the foam solution that has been premixed at a specific percentage. There are 2 types of premix systems.

Pressure-type systems use a pressure vessel for the tank and compressed gas, usually nitrogen, to propel the premixed foam solution from the discharge device. These systems are usually installed on quick attack-type apparatus to take advantage of the instant activation feature of this type of foam system. Pressure-type premix systems have the following limitations:

(a) Fixed foam solution percentage once the foam solution is prepared.

(b) Size and weight of the pressure vessel.

(c) Pressure limitation of the pressure vessel.

(d) System cannot be recharged while the system is in operation.

Suction-type systems use an atmospheric tank that is connected to the water pump intake. The premixed foam solution is drawn directly into the pump and discharged as required. A suction system can be created by adding the correct amount of foam concentrate to the water tank on the fire apparatus. Suction-type premix systems have the following limitations:

(a) Fixed foam solution percentage once foam solution is prepared.

(b) Water and foam solution cannot be discharged simultaneously from the pump. Once activated, the system produces foam solution from all open pump discharge outlets.

(c) System is difficult to recharge when system is in operation.

(d) Foam concentrates must be mechanically mixed with water to create foam solution.

Caution: Adding foam directly to the water tank on a piece of apparatus that was not specifically designed for premix usage will cause damage to the tank, plumbing, and pump.

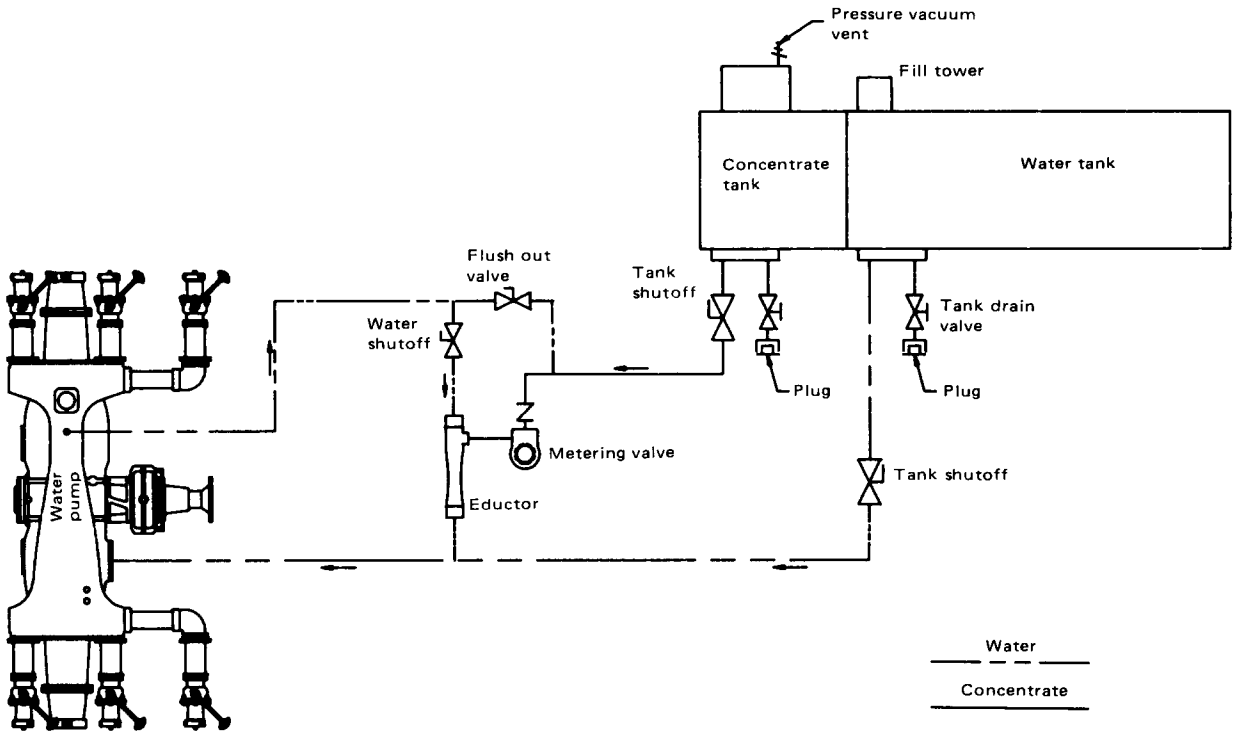

Figure A-8-3.2.3(a) Manual Variable Metering, Around-the-Pump Proportioning System.

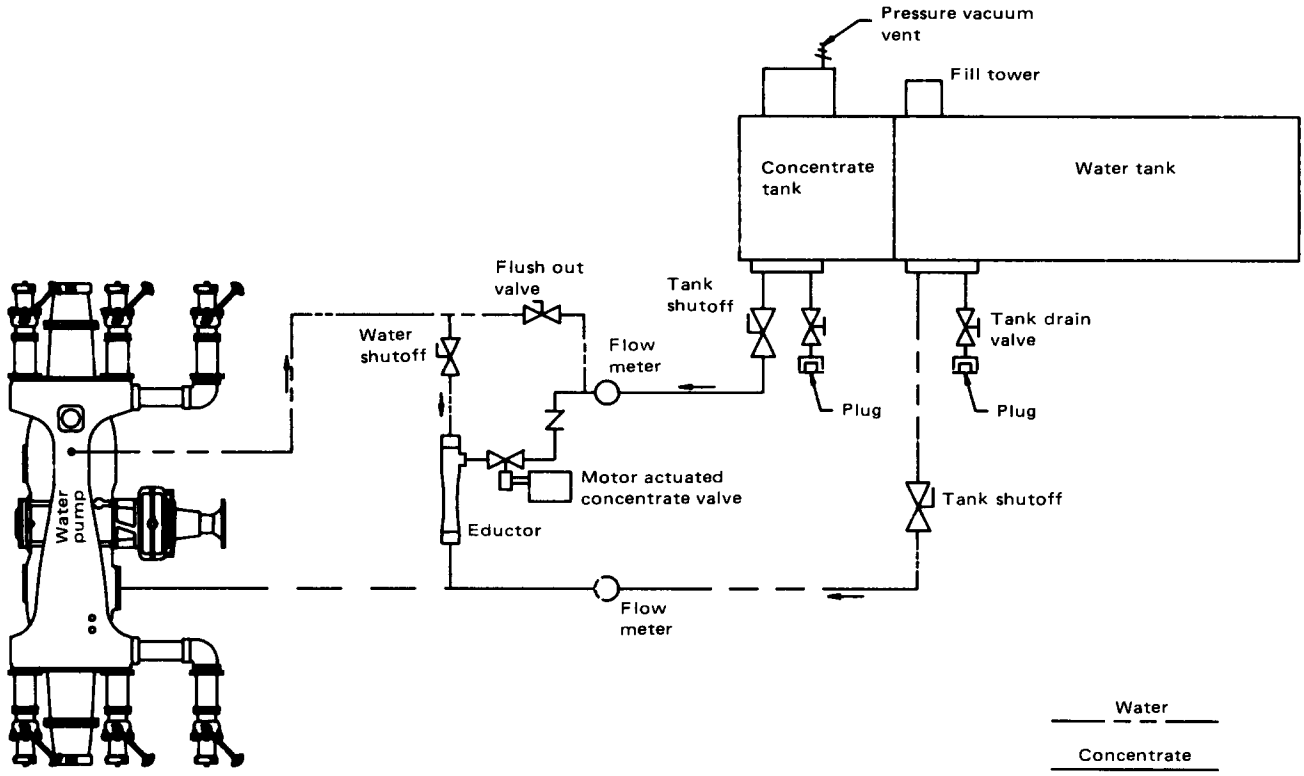

Figure A-8-3.2.3(b) Automatic Variable Metering, Around-the-Pump Proportioning System.

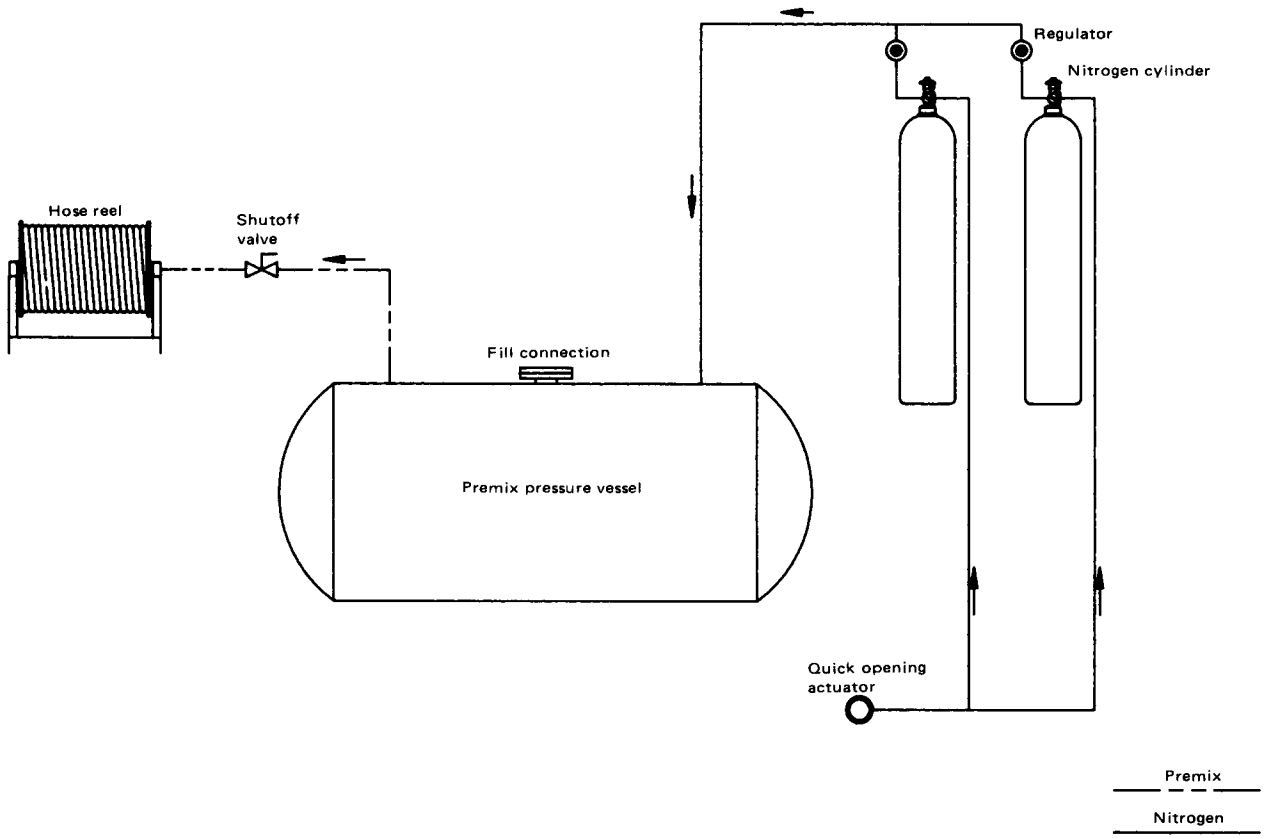

Figure A-8-3.2.4 Pressure-Type Premix System.

A-8-3.2.5 Balanced pressure foam proportioning systems are installed on the discharge side of the water pump. Two orifices discharge water and foam concentrate into a common ratio controller (proportioner) located in the water pump discharge. By adjusting the area of the orifices to a particular ratio, the percent of injection can be adjusted if inlet pressures are equal. The method of controlling or balancing the foam concentrate pressure with the water pressure varies with different balanced pressure system designs. The 2 basic methods of balancing the pressures are systems without a foam concentrate pump and systems with a concentrate pump.

Balanced pressure systems without a foam concentrate pump are referred to as "pressure proportioning systems." These systems utilize a pressure vessel with an internal bladder to contain the foam concentrate. When in operation, water pump pressure is allowed to enter the pressure vessel and exert pressure on the internal bladder. The foam concentrate is forced out of the bladder to the proportioner at a pressure equal to the water pressure. These systems are easy to operate and offer fixed or variable rate proportioning. Pressure proportioning systems have the following limitations:

(a) Size and weight of the pressure vessel.

(b) Capacity of the pressure vessel.

(c) Pressure limitation of the pressure vessel.

(d) Unit cannot be recharged when the system is in operation.

A balanced pressure system with a foam concentrate pump may be one of two basic types. A "by-pass" system utilizes a diaphragm valve in the concentrate pump-to-tank line that automatically controls foam pump pressure by by-passing excess foam concentrate back to the tank. A "demand" system controls the pump speed, which controls pump pressure. Balanced pressure systems have no real operating limitations except by specific design. These systems have no water intake limitations, and discharge capacity and pressure is limited only by design. Foam solution can be discharged from any water pump outlet, equipped with a proportioning device, at various percentage rates up to system design capacity. Water and foam solution can be discharged simultaneously from the water pump. Accurate foam proportioning is available over a wide range of flow and pressure. The foam concentrate pump can be used to refill the foam concentrate tank at any time, even when the system is operating.

Balanced pressure foam proportioning systems are more complex than other types of systems and generally more expensive. However, they have the following advantages:

(a) There is no water inlet pressure limitation.

(b) Discharge capacity is limited only by design.

(c) Foam solution can be discharged from any water pump outlet equipped with a proportioning device at various percentage rates up to the system design capacity.

(d) Water and foam solution can be discharged simultaneously.

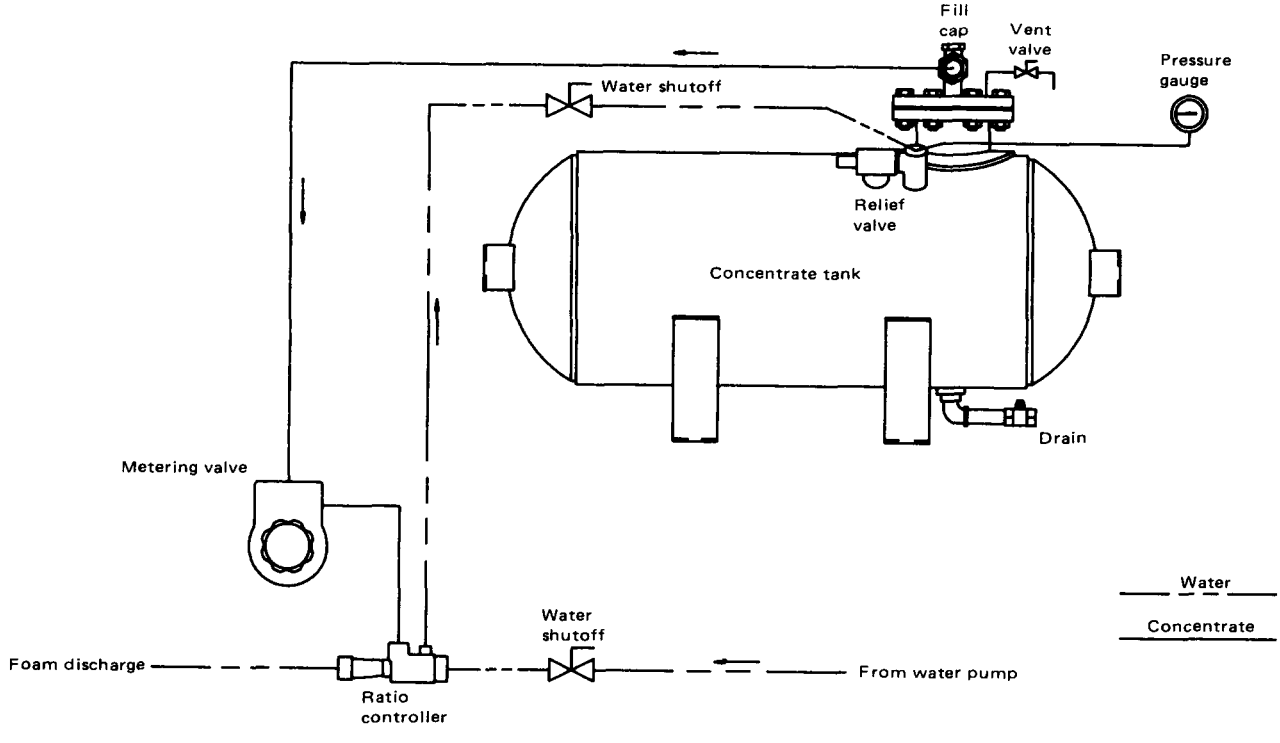

Figure A-8-3.2.5(a) Pressure Proportioning System.

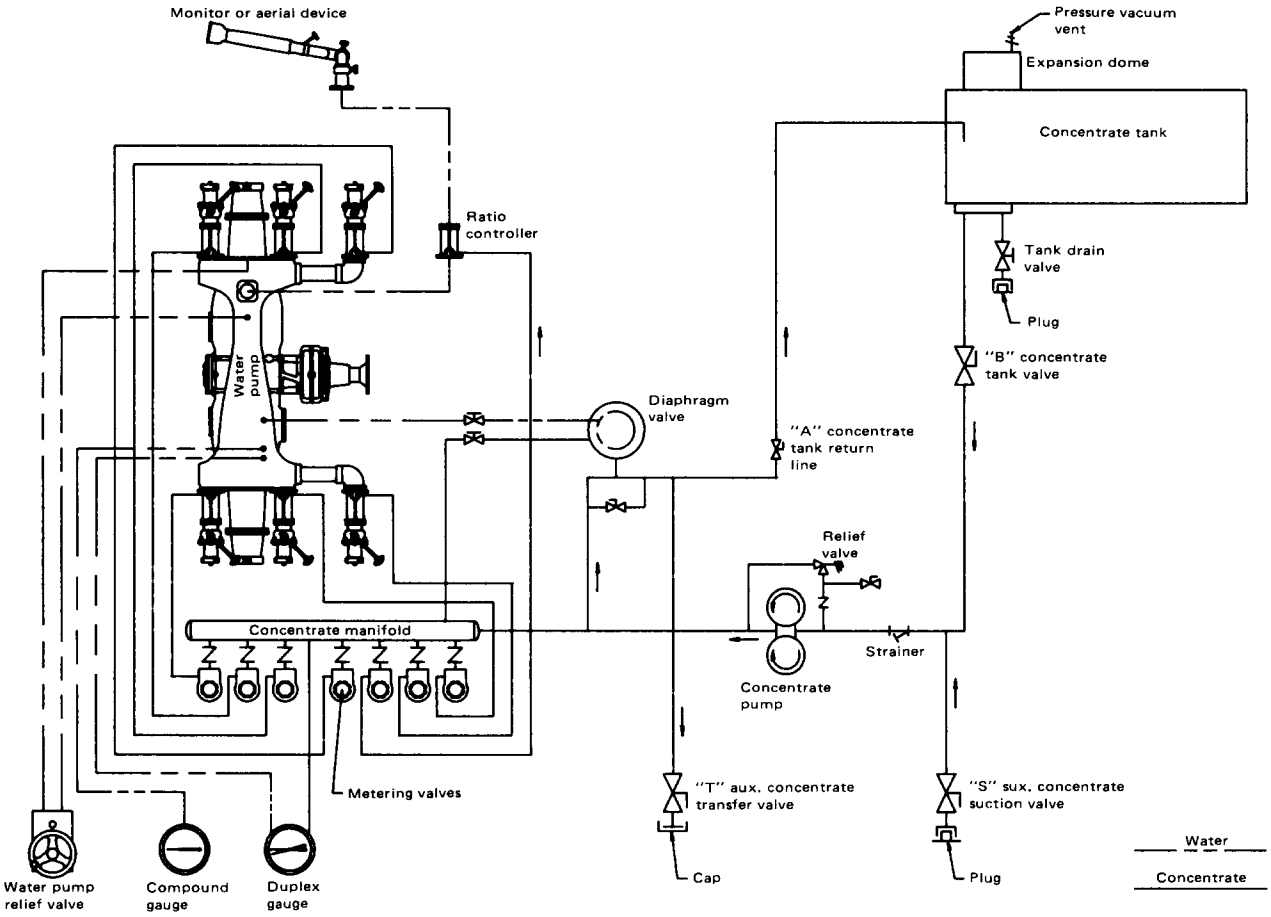

Figure A-8-3.2.5(b) By-pass Balanced Pressure Proportioning System.

A-8-3.2.6 Direct injection foam proportioning systems utilize a foam concentrate pump to inject foam concentrate directly into the water pump discharge. A flow meter(s) is installed into the water pump discharge to measure the water flow rate. The flow meter(s) signal is used by a microprocessor to control the output of the foam concentrate pump. A measurement of the foam concentrate pump output is fed back to the microprocessor to maintain the foam concentrate flow rate at the proper proportion to the water flow rate. Direct injection systems have no real operating limitations except by specific design. Water and foam solution can be discharged simultaneously from the water pump. Accurate foam proportioning is available over a wide range of flow and pressure. Direct injection systems have the following advantages.

(a) They do not introduce a pressure loss into the water pump discharge.

(b) They automatically adapt to changing water pump inlet or discharge pressure conditions.

(c) They are simple to operate.

(d) The foam concentrate can be refilled during operation.

(e) Injection rates are operator adjustable.

Compressed air foam systems (CAFS) are a derivation of the direct injection foam proportioning system. This type of system incorporates an onboard foam agent pump and air compressor in conjunction with a water pump. The foam agent system monitors water flow with a flow meter installed in the water pump discharge. Foam agent pump output is regulated by an agent metering control unit that provides accurate control of the foam agent percent of injection. Air injection is controlled by an air pressure regulator. Foam agent and compressed air are properly mixed by a mixer unit installed in the water pump discharge.

A-8-3.3.2 Different types and brands of concentrates may be incompatible with each other and should not be mixed in storage. Foams generated separately from protein, fluoroprotein, and AFFF concentrates may be applied to a fire in sequence or simultaneously.

A-8-3.3.4 Most foam concentrate manufacturers differentiate in their material recommendations between those foam proportioning system components that are designed to be flushed with water after operation and those components that are intended to store the foam concentrate.

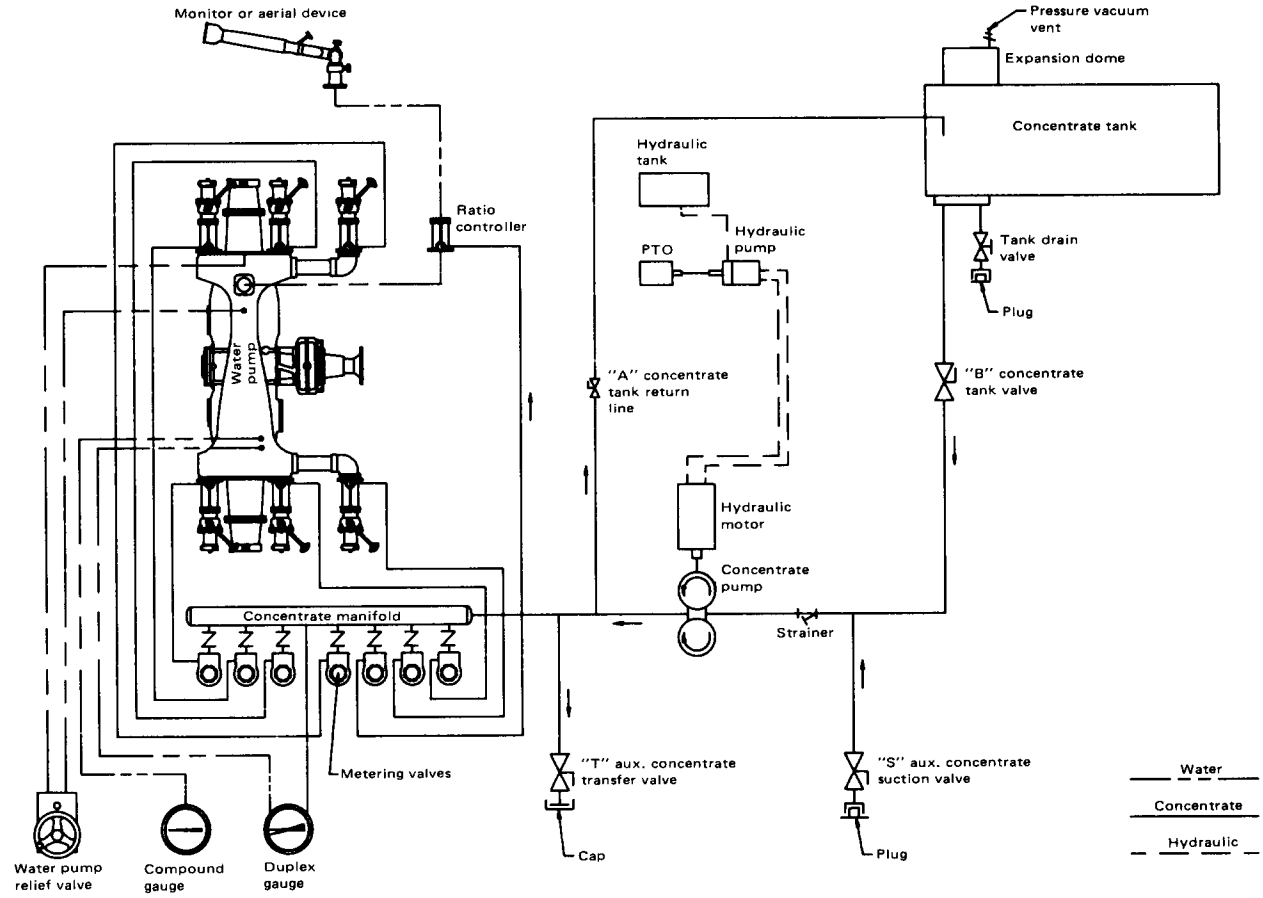

Figure A-8-3.2.5(c) Demand Balanced Pressure Proportioning System.

A-8-3.7.6 A removable top is recommended; however, alternate systems are acceptable for special tanks such as oval tanks and tanks less than 200 gal (757 L).

A-8-3.10 The foam concentrate pump is a very critical component of both balanced pressure and direct injection foam proportioning systems. Positive displacement pumpsare recommended for several reasons. Positive displacement pumps are relatively slow speed when compared to centrifugal pumps, which are desirable with viscous foam concentrates that are difficult to shear. Centrifugal pumps can become air bound when trying to pump viscous foam concentrates, which results in a complete shutdown of the system. The self-priming feature of positive displacement pumps allows them to draw foam concentrate from drums or any external source without priming the pump.

A-8-4.1 Apparatus provided with booster hose and reel assemblies should be equipped with an air chuck mechanism to allow connection of an external source of compressed air to facilitate removal of water within the booster hose assembly. This mechanism should be located on the discharge side of the booster reel valve. Draining booster reels is often necessary to prevent damage by freezing.

A-8-5.5.1 Water, hose, ground ladders, and equipment on the apparatus all provide stability when they are in place. However, at a fire, this equipment and water is often removed. Therefore, stability needs to be measured under the worst conditions, which is with the equipment removed.

A-8-5.5.1.3 The lifting of a tire or stabilizer on the opposite side of the vehicle from the load does not necessarily indicate a condition of instability.

A-8-5.6.4 It may be desirable to provide an override system to deactivate the interlocks when it is necessary to operate the device with reduced payload or reach. Where an override system is specified, it should require the action of a person in addition to the operator to deactivate the interlock system. Where an override system is provided, it is also advisable to provide an indicator at all aerial device operating positions to warn the operator that the override controls have been activated.

A-8-5.6.5 Water tower operational controls should be located such that the operator can see the tip of the water tower in all operating positions.

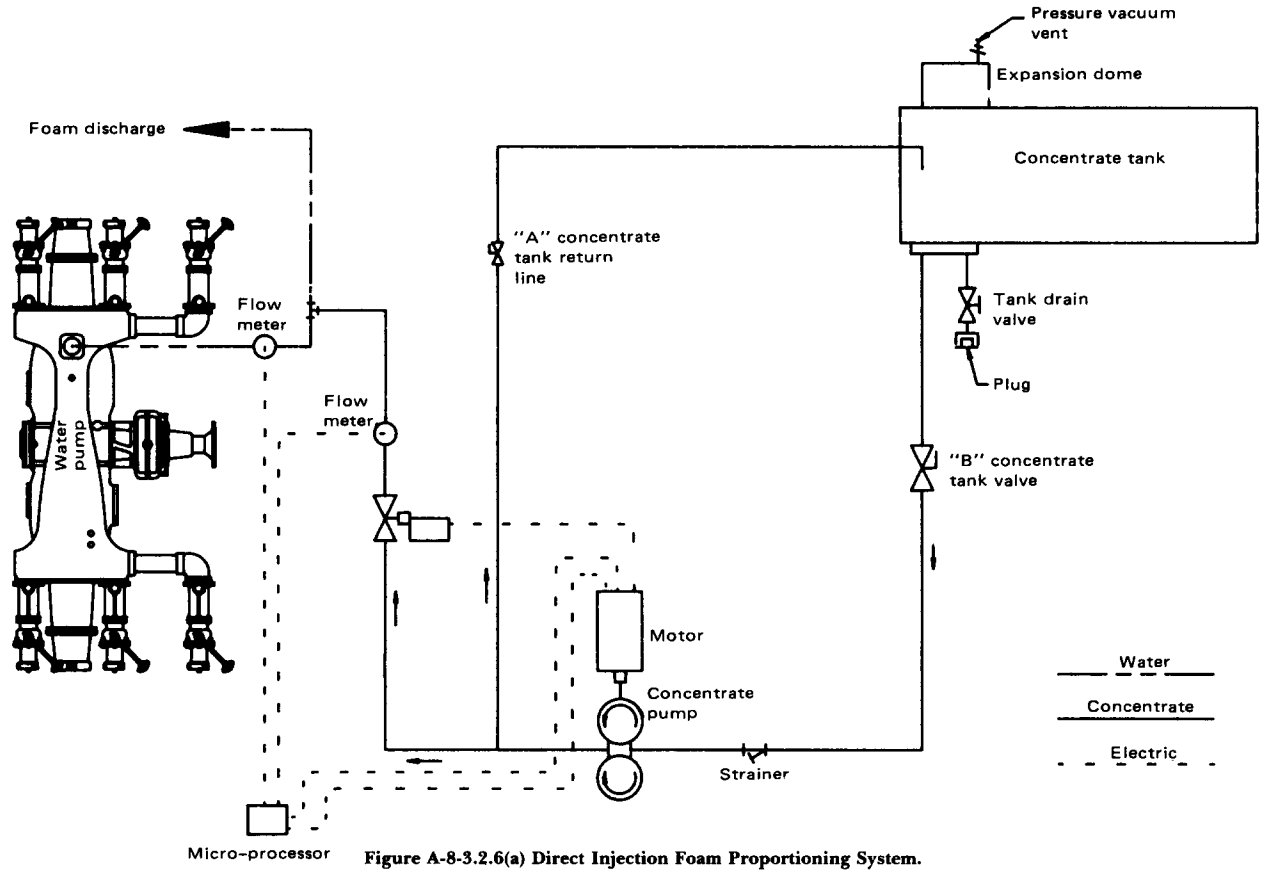

Figure A-8-3.2.6(a) Direct Injection Foam Proportioning System.

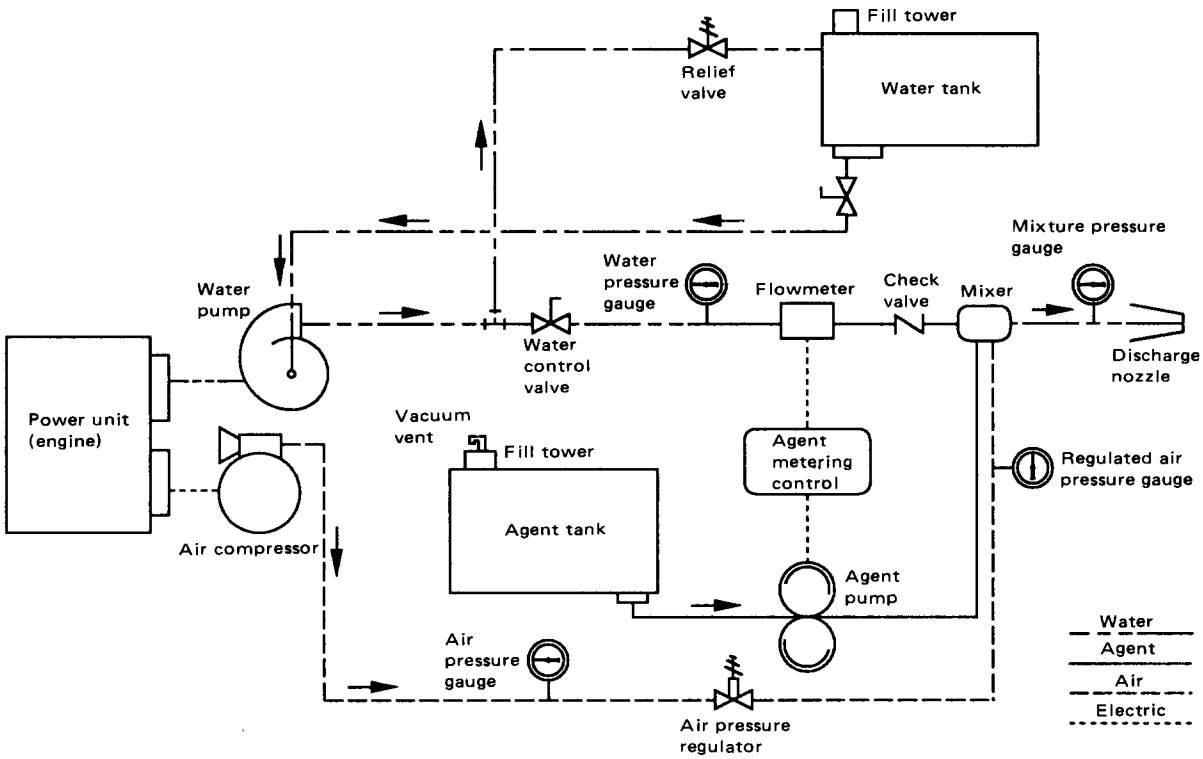

Figure A-8-3.2.6(b) Compressed Air Foam System.

A-8-5.9.4 The arrangement of the auxiliary inlet should be specified by the purchaser based on local operations in supplying water to the waterway. If normal operations are to supply the waterway with large diameter hose, a valve should be provided. A gated 3- or 4-inlet siamese should be provided when 2½- or 3-in. (65- or 76-mm) supply lines are used.

Attention needs to be paid to the inlet arrangement to limit friction loss. Also, if the purchaser desires to use the auxiliary inlet as a discharge, a slow acting valve must be installed in the riser to the swivel.

A-8-5.9.6 When freezing conditions are expected, an automatic drain valve should be specified in order to drain the waterway when water is not flowing.

A-8-5.10.1 The following combination of loadings would be evaluated for compliance with the standard. To clarify, the following terms are defined.

DL = Dead load stress. Stress produced by the aerial device structure and all materials, components, mechanisms, or equipment permanently fastened thereto.

RL = Rated vertical load stress. Stress produced by rated capacity of the aerial ladder applied at the tip of the fly section. (Minimum 250 lb at 0° elevation and full extension.)

WL = Water reaction stress. Stress produced by nozzle reaction and weight of water.

FY = Material yield strength. The stress at which a material exhibits a specified permanent distortion or set.

With no water in system, full rated capacity, full extension, and 0 degree elevation, the criteria are:

$$2 \times DL + 2 \times RL \leq FY$$

With water flowing in the system, in worst rated position, the criteria are:

$$2 \times DL + 2 \times RL + WL \leq FY$$

A-9-2.3 Some test data blanks for recording the test readings and other necessary data should be provided.

When a pumper is pumping at or near full engine power while stationary, the heat generated may raise the temperature of certain chassis or pumping system components above the level that can be touched without extreme discomfort or injury; however, as long as the apparatus can be operated and used satisfactorily for the required duration of the test under such conditions it should be considered acceptable.

The dynamic suction lift can be determined by either measuring the negative pressure (vacuum) in the pump intake manifold by means of a manometer (or other suitable test gauge that measures vacuum accurately) or by adding the vertical lift and the value of friction and entrance loss from Table 4-1.3.1(b). To be accurate, gauge readings should be corrected for the difference between the height of the gauge and the center line of the pump intake, but usually this is not a significant amount and may be ignored. Thus, the net pump pressure can be calculated by one of the following formulas:

1. If intake pressure is positive, i.e., pumping from a hydrant: $P = D - S$

2. If intake pressure is negative, i.e., pumping from draft: $P = D + (H \times 0.5)$ or $P = D + 0.43 (L + F)$, where

P = net pump pressure, psi
D = discharge pressure, psig
S = intake pressure, psig
H = manometer reading, in. Hg
L = vertical lift, ft
F = friction and entrance loss, ft of water.

A-9-9.3.2 All portable cord sets and electrical equipment supplied with the apparatus should also be checked for electrical polarity.

A-9-9.4.1 There are 3 methods to test a foam proportioning system for calibration accuracy.

(a) 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.

(b) With the foam system in operation at a given flow, a solution sample is collected from each outlet and the concentration measured by refractometer.

A refractometer is used to determine the concentration of foam stabilizer in the water being used to generate foam and is useful for checking the accuracy of a system's proportioning apparatus. If the concentration deviates too widely from the designed level, it will abnormally influence the expansion and drainage time values. The test is based on the change of refractive index of the solution with change in concentration as measured by the refractometer.

Apparatus required:

3 - 100-ml graduates
1 - measuring pipette (10-ml capacity)
1 - 100-ml beaker
1 - 500-ml beaker
1 - refractometer (hand juice refractometer)
range: 0 to 25 percent sugar content or 1.3330 to 1.3723 index of refraction.

Procedures. The first step is to prepare a calibration curve for the intended use. This has been found necessary because the source of water and batch of foam concentrate will affect the results. If the foam liquid in use is of the 6 percent type, standard solutions of 3 percent, 6 percent, and 9 percent are made up from the water and foam liquid identical with the material to be used in the test. This is done by pipetting 3, 6, and 9 ml of foam concentrate respectively into three 100-ml graduates and then filling to the 100-ml mark with the water. If the 3 percent type foam concentrate is being used, then standard solutions of 1.5 percent, 3 percent, and 4.5 percent concentrations should be made up.

After thoroughly mixing, a refractive index reading is taken of each standard. A plot is made on graph paper of the scale readings against the known foam solution concentrates and serves as a calibration curve for this particular foam test series. Portions of solution drained out during

drainage rate tests are conveniently used as a source of samples for the refractometer analysis. Refractive readings of the unknown are referred to the calibration curve and the corresponding foam solution concentration read.

NOTE: The calibration readings and test readings should all be made at the same temperature. Samples taken for analysis should be stored in tightly stoppered containers and analyzed immediately.

(c) A third test method is available with some direct injection systems. It is possible to directly measure foam concentrate pump output. With the foam system in operation at a given water flow, the concentrate pump discharge can be diverted into a calibrated container for direct measurement over a period of time.

A-9-11 Where the point of delivery is over 2000 ft (610 m) of elevation, the pumping engine overload test described in Section 9-3 should be performed to ensure that the engine will develop adequate power at point of delivery. This test may be performed with the pump supplied from a suitable fire hydrant, or at draft, with the net pressure maintained at 165 psi (1138 kPa). The net pressure (P), when the pump is supplied from a hydrant with positive intake pressure, is the discharge pressure (D) in psig minus the intake pressure (S) in psig.

Figure A-9-12.1(b)
Manufacturer's Record of Pumper Construction Details.

Date _____

1. Owner _____ Address _____
2. Manufacturer _____ Model _____ Ser. No. _____
3. Engine Make _____ Model _____ Ser. No. _____
4. No. Cyls. ___ Bore ___ Stroke ___ Displ. ___ Cu In.
5. Rated HP ___ at ___ rpm No-Load Governed rpm ___
6. Comp. Ratio _____ :1 Type _____
7. System Voltage ___ vs. Alternator Output ___ Amps
8. Battery: Single or Dual _____ Capacity _____ CCA
9. Battery: Make and Model _____
10. Fuel Tank Capacity _____ Gal Type of Feed _____
11. Cooling System: Heat Exchanger? _____
12. Transmission: Make _____ Model _____ Type _____
13. Drive to Pump through Transmission? _____
14. Gear Ratio Engine to Pump _____ :1
    Trans. Gear Ratio Used _____
15. Pump Make ___ Model ___ Rated Capacity ___ gpm
16. Serial No. ___ No. Stages ___ Impeller Dia. ___ In.
17. Priming Device Type _____
18. Relief Valve? _____ Pressure Governor? _____
19. Auxiliary Pump? _____ Make _____ Model _____
20. Water Tank Capacity _____ Gal
21. Chassis Make _____ Model _____ Ser. No. _____
22. GAWR Front _____ lb Rear _____ lb
23. Tires Front Size _____ Rated Capacity Total _____ lb
24. Tires Rear Size _____ Rated Capacity Total _____ lb
25. Chassis Weight Distribution with Water and Equipment Front _____ lb
26. Chassis Weight Distribution with Water and Equipment Rear _____ lb
27. Paint # _____ Paint # _____
28. Company _____
29. Signed by _____

Appendix B

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

History of Specification. A report of the NFPA Committee on Fire Engines adopted at the 1906 NFPA Annual Meeting included many of the provisions and test procedures since followed in standards for fire department pumping apparatus.

At the convention of the International Association of Fire Engineers in 1911, the Committee of Exhibits conducted some performance tests on automobile pumping engines. The following year, with the assistance of engineers of the National Board of Fire Underwriters, tests were conducted on pumping engines discharging under net pump pressures of 120 psi, 200 psi, and 250 psi. By the 1913 convention of the International, the committee had developed a standard test procedure of specified duration.

The first national specification on municipal fire apparatus was NFPA 19, *Automobile Fire Apparatus, Suggested Specifications for Combination Pumping Engine and Hose Wagon*, and was adopted by the National Fire Protection Association in 1914. This was followed in 1916 by specifications adopted by the Association covering an automobile combination chemical and hose wagon and an automobile service ladder truck. These specifications received the endorsement of the Committee on Fire Department Engineering of the International Association of Fire Engineers and were adopted and published in 1920 by the National Board of Fire Underwriters. The work of the original NFPA Committee on Automobile Apparatus was suspended in 1920.

A new NFPA Committee on Municipal Fire Apparatus was organized in 1938, and the Association adopted revised editions in 1938, 1939, and 1942. In 1948 the present Committee on Fire Department Equipment was organized. The scope of the committee was broadened to include fire department tools and appliances as well as motorized fire apparatus for both municipal and rural service. There have been numerous revisions of the standard to keep it abreast of current practice, and editions were issued in 1949, 1950, 1951, 1952, 1954, 1955, 1956, 1957, 1958, 1960, 1961, 1963, and 1965.

The work of this committee has been an outstanding example of cooperation among the various fire service organizations concerned with standards for fire department apparatus and equipment. A chief engineer of the former National Board of Fire Underwriters was chairman of the original committee. A very significant contribution of the National Board over half a century was the listing of thousands of pump and engine combinations that met the specified pumper performance requirements. Recognition is also due the various insurance rating and inspection bureaus, most of which are now part of the Insurance Services Office, whose representatives have witnessed the acceptance tests of apparatus built under these specifications.

The International Association of Fire Chiefs has actively participated in this work since 1912. A fire chief has served as chairman of the committee responsible for these specifications since 1938. In 1952 the Technical Committee of the Fire Apparatus Manufacturers Association was reactivated and has made significant contributions to each subsequent edition of these specifications.

In 1965 the American Insurance Association (A.I.A.), who replaced the National Board of Fire Underwriters, decided that field testing by Rating Bureaus and record-keeping by the A.I.A. would have to cease. The Fire Department Equipment Committee in conjunction with Underwriters Laboratories Inc. and the Technical Committee of the Fire Apparatus Manufacturers Association worked with A.I.A. to transfer the testing program to U.L.I. This program appeared in the standard in the 1966 edition and has been the accepted testing program since then.

Further revisions were completed and editions issued in 1967, 1968, 1969, 1970, 1971, and 1973. In 1975 the number of the document was changed to NFPA 1901 in a general renumbering of public fire protection standards, and the name was changed to *Standard on Automotive Fire Apparatus*. Partial revisions were made and new editions issued in 1979 and 1985.

The 1991 edition has been extensively rewritten and split into 4 documents. This document covers pumper fire apparatus. The others cover initial attack fire apparatus (NFPA 1902), mobile water supply fire apparatus (NFPA 1903), and aerial ladder and elevating platform fire apparatus (NFPA 1904).

Appendix C

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

It is the responsibility of the purchaser to provide the contractor with sufficient information to enable the contractor to prepare a bid and a complete description of the apparatus the contractor proposes to supply. Completion of the following questionnaire by the purchaser will provide the information required in the various sections of this document. The column titled "Section" indicates where in the document the requirement or recommendation is stated.

Type of Information	Section
GENERAL	
Date of Bid Opening _____	A-1-3
Purchaser's Name & Address _____	
_____	
Contact Name & Telephone Number _____	
_____	
_____	
Sealed bid envelope information, address, and identification marking. _____	
_____	
The bidder is to honor the bid price for _____ days.	A-1-3
If interim inspection trip(s) to the assembly plant are to be provided, indicate the number of trips and number of participants _____	A-1-3
How many service and operation manuals are to be provided? _____	2-2.2
Where is the delivery of the apparatus to occur? _____	A-1-3
Where and when is the acceptance to occur? _____	2-2.3