25.4.4.2 The receptacle shall have a label indicating its use.

25.4.4.3 The power cord from the receptacle to the winch shall be sized for the power requirements of the winch.

25.4.4.4 The power cord shall be highly flexible and shall be protected from mechanical damage.

25.5 Hydraulically Driven Winches.

25.5.1 Hydraulic Hose.

25.5.1.1 All hydraulic hose shall be designed for the hydraulic pressures expected to be encountered.

25.5.1.2 Hose shall be a wire-braided type with a female swivel on one end.

25.5.2 Operation of the hydraulic winch shall be from a remote location at least 12 ft from the winch or within an enclosed area.

25.5.3 Hydraulic Reservoir.

25.5.3.1 The hydraulic system components shall be capable of maintaining, under all operating conditions, oil cleanliness and temperature that comply with the manufacturer's recommendations.

25.5.3.2 A means for checking and filling the hydraulic reservoir shall be readily accessible.

25.5.3.3 The fill location shall be conspicuously marked with a label that reads "Hydraulic Oil Only."

25.5.3.4 The manufacturer shall provide instructions for checking and filling the hydraulic reservoir.

25.5.4 The hydraulic winch engagement controls shall be located in the driving compartment.

25.5.4.1* A "Hydraulic Winch Engaged" indicator shall be provided in the driving compartment to indicate that the hydraulic pump engagement has been successfully completed.

Chapter 26 Trailers

26.1 General. For the purposes of this standard, trailers transporting equipment or other vehicles under emergency response conditions shall be considered fire apparatus, and any components on the trailer designed to support emergency services operations shall meet the applicable requirements defined in Section 4.5.

26.2 Classification of Trailers. Trailers shall be classified as Type I, Type II, or Type III.

26.2.1* Trailers that are designed to remain connected to their tow vehicle throughout the response event and that are dependent on the tow vehicle to provide the required electrical power and conspicuity shall meet the requirements of this chapter for Type I trailers.

26.2.2* Trailers that are designed to allow separation from their tow vehicle after arrival at the response event and that are not dependent on the tow vehicle to provide the required electrical power and conspicuity shall meet the requirements of this chapter for Type II trailers.

26.2.3* Open trailers designed to transport other vehicles, equipment, or containers that will be removed from the trailer after arrival at the response event and that will not be blocking the right-of way during the incident shall meet the requirements of this chapter for Type III trailers.

26.3 Carrying Capacity.

26.3.1 The GVWR of the trailer shall not be greater than the sum of the tongue weight and the GAWR.

26.3.2 The stated load capacity of the trailer shall be the GVWR of the trailer less the empty weight of the trailer and the weight of the permanently mounted equipment.

26.4 Information Labels and Instruction Plates.

26.4.1 In addition to the label required by 49 CFR 567, "Certification," the final stage manufacturer shall permanently affix an information label that includes the following:

(1) The length and width of the completed trailer in feet/inches (meters)
(2) The stated load capacity
(3) For Type I and Type II trailers, the height of the completed trailer in feet/inches (meters)
(4) The hitch size and type
(5) Maximum tire pressure
(6) The tire manufacturer's maximum speed rating
(7) The proper hitch-locking procedures to secure the trailer to the tow vehicle
(8) A statement that reads: "It is the vehicle operator's responsibility to ensure that the towing vehicle and hitch are adequate to pull this trailer."

26.4.2 For trailers requiring the use of safety chains, an instruction plate shall be provided at or near the hitch location on the trailer that indicates the proper method of chain attachment to the tow vehicle.

26.4.3 For trailers with a braking system, an instruction plate shall indicate the proper method of connecting the braking system and the breakaway cable connections that apply the emergency brakes in the event the hitch fails.

26.5 Fluids and Pressures Specific to the Trailer Chassis. A permanently mounted informational label shall be provided to specify the following information if it applies:

(1) Brake fluid for trailer brake systems
(2) Grease used for the lubrication of axle bearings
(3) Any other special fluids, pressures, or lubricants required by the trailer manufacturer

26.6 Braking System.

26.6.1* All trailers chassis with a GVWR of 3000 lb (1360 kg) or greater shall be equipped with a braking system on each axle.

26.6.2 All trailers equipped with brakes shall be equipped with a method to use the braking system to limit trailer movement in the event of failure of the hitch mechanism.

26.6.3 All brakes shall be readily accessible for adjustment.

26.6.4 When tow vehicles and trailers are equipped with air brake systems, the service brakes and parking brakes shall be applied by independent means.

26.7 Suspension and Wheels.

26.7.1 Each load-bearing tire and rim shall not carry a weight in excess of the recommended load for the operation of the

tires used, as published in *Tire and Rim Association — Year Book* and as recommended by the tire manufacturer.

26.7.2* Any trailer with an angle of departure of less than 8 degrees shall be equipped with means to prevent damage to the trailer if the rear contacts the ground.

26.8 Trailer Hitch.

26.8.1 The trailer hitch shall be selected to meet or exceed the GVWR of the trailer.

26.8.2 The construction and load supported by the trailer frame shall be distributed to maintain a tongue weight at or below the tongue weight rating.

26.8.3 Safety Chains.

26.8.3.1 The installation and use of two safety chains shall be required for trailer hitches designed to use safety chains.

26.8.3.2 Each safety chain and the method of attachment to the trailer and towing vehicle shall have an ultimate strength of not less than the gross weight of the trailer.

26.8.4 When using a fifth wheel hitch, the fifth wheel hitch and trailer body design shall allow full 90-degree jackknifing of the tow vehicle–trailer combination when all doors and exterior mounted items are in the stowed position.

26.9 Wheel Chocks.

26.9.1 For trailers classified as Type II or Type III, four wheel chocks shall be mounted in readily accessible locations.

26.9.2 Each wheel chock shall be designed to hold the trailer on a 10 percent grade when the trailer is loaded to its GVWR and parked independently of the tow vehicle.

26.10 Low Voltage Electrical Systems and Warning Devices.

26.10.1 Any low voltage systems, umbilical cables, and warning devices installed on trailers shall be appropriate for the mounting location and intended electrical load and shall meet the specific requirements of Chapter 13.

26.10.2 If the trailer is classified as Type I or Type II, it shall meet the requirements of Section 13.11.

26.10.3 Power Supply.

26.10.3.1 The final-stage trailer manufacturer shall state the minimum continuous electrical load required to be provided by the tow vehicle.

26.10.3.2 If the trailer is classified as Type I, the combined tow vehicle and trailer shall meet the electrical requirements in Chapter 13.

26.10.3.3 If the trailer is classified as Type II, the combined electrical load for the federally required clearance and marker lighting and the optical warning devices shall not exceed 45 amps.

26.10.3.3.1 An on-board power source shall be provided and sized to power all trailer electrical loads on a continuous basis.

26.10.3.3.2* If a line voltage power source is used, it shall meet the requirements of Chapter 22.

26.10.3.4 If the trailer is classified as Type III, the combined electrical load for the federally required clearance and marker lighting and the optical warning devices shall not exceed 45 amps.

26.10.4* Umbilical Cables and Connections.

26.10.4.1 Umbilical cables shall be constructed of cable that complies with the requirements of Chapter 13.

26.10.4.2 Umbilical cables shall be installed and supported to prevent abrasion or chafing damage during normal operation of the trailer.

26.10.4.3 The umbilical cables shall move freely throughout the trailer's operating range of full turn right to full turn left without damage.

26.10.4.4 For trailers using air brakes, the umbilical cable for the federally required clearance and marker lighting and the ABS brake system shall be connected using a green Type F cable meeting SAE J2394, *Seven-Conductor Cable for ABS Power — Truck and Bus*, and primary connectors meeting SAE J560, *Primary and Auxiliary Seven Conductor Electrical Connector for Truck-Trailer Jumper Cable*. Circuit identification shall conform to SAE J560, Table 4.

26.10.4.5 For trailers using electric or hydraulic brakes, or small trailers without brakes, the umbilical cable for the federally required lighting and brake system shall be connected using a seven-wire heavy-duty cable and a seven-way flat-blade recreational vehicle connector meeting SAE J2863, *Automotive Trailer Tow Connector*.

26.10.4.6 The optical warning device umbilical cable shall be a yellow cable meeting the requirements of SAE J2394 for Type F cable with auxiliary connectors meeting SAE J560.

26.10.4.6.1 The auxiliary connectors shall have inverted ground terminals to prohibit connection to the primary receptacle (male ground terminal in the plug and the female ground terminal in the receptacle).

26.10.4.6.2 Circuit identification shall conform to SAE J560, Table 4, with the unassigned circuits assigned as follows:

(1) 12 — Green, hazard light signal from trailer *(see 13.11.1)*
(2) 13 — Brown, calling for right-of-way warning lights
(3) 14 — Blue, blocking right-of-way warning lights

26.10.5 Optical Warning Devices.

26.10.5.1 If the trailer is a Type I trailer, the optical warning system requirements of Section 13.8 shall be met by considering the combined tow vehicle and trailer as a single unit with its overall length.

26.10.5.2 If the trailer is a Type II trailer, the optical warning system shall meet the requirements of Section 13.8 when the trailer is considered a single unit.

26.10.5.2.1 The trailer's Zone A lighting shall operate only when the trailer's onboard power source is operational and the tow vehicle is disconnected from the trailer.

26.10.5.3 If the trailer is a Type III trailer, the optical warning system shall meet the requirements of Section 13.8 for lower zones B, C, and D.

26.10.6 Work Lighting.

26.10.6.1 Type I and II trailers shall be equipped with ground lighting that meets the requirements of 13.10.1.2.

26.10.6.2 If the trailer has work surfaces, steps, or walkways, those surfaces shall be equipped with surface lighting that meets the requirements of 13.10.3.

26.10.6.3 If the trailer has interior spaces where a person can walk, the trailer shall be equipped with interior lighting that meets the requirements of 13.10.4.

26.10.6.4 If the trailer has compartments, the compartments shall be equipped with compartment lighting that meets the requirements of 13.10.5.

26.10.7 Stop, Tail, and Directional Lighting. The trailer shall be equipped with stop, tail, and directional lighting meeting the requirements of Section 13.13.

26.10.8 Electrical System Performance Tests.

26.10.8.1 Low voltage electrical systems shall be tested in accordance with the testing requirements of Chapter 13 as applicable.

26.10.8.2 Line voltage electrical systems shall be tested in accordance with the testing requirements of Chapter 22 as applicable.

26.11 Reflective Markings.

26.11.1 Type I trailers shall meet the requirements of 15.9.3 when the combined tow vehicle and trailer are considered a single unit with the overall length.

26.11.2 Type II trailers shall meet the requirements of 15.9.3 when the trailer is considered a single unit.

26.11.3 Reflex reflectors and conspicuity tape shall be installed when required by 49 CFR 571.108, "Lamps, reflective devices, and associated equipment."

Chapter 27 Reserved

Chapter 28 Ultra-High Pressure Fire Pumps and Associated Equipment

28.1 Application. If the apparatus is equipped with an ultra-high pressure fire pump, the provisions of this chapter shall apply.

28.2 Pump Performance.

28.2.1 An ultra-high pressure fire pump shall have a minimum rated capacity of 6 gpm (25 L/min) and shall have a rated discharge pressure greater than or equal to 1100 psi (7600 kPa).

28.2.2 The rating for ultra-high pressure fire pumps shall be based on the pump taking water from the apparatus water tank.

28.2.3 If the completed pumping system is capable of taking suction, it shall do so within 30 seconds under the following conditions:

(1) At an altitude of 2000 ft (600 m) above sea level
(2) Through 10 ft (3 m) of suction hose of the size specified in Table 28.2.3 and equipped with a suction hose strainer
(3) With a lift of 3 ft (1 m)
(4) At 29.9 in. Hg (101 kPa) atmospheric pressure (corrected to sea level)
(5) At a water temperature of 60°F (16°C)

Table 28.2.3 Suction Hose Size by Pump Capacity Rating

Flow Rate		Minimum Suction Hose Size	
gpm	L/min	in.	mm
20 and less	80 or less	1	25
30	120	1½	38
50	200	2	52
100	400	2½	65
150	600	2½	65
200	800	2½	65
250	1000	3	75
300	1200	3	75

28.2.4* The pump manufacturer shall certify for each ultra-high pressure fire pump the rated capacity in gpm (L/min), rated discharge pressure in psi (kPa), and net positive suction head required (NPSHR) in ft (m) of water at 60°F (16°C) and 29.9 in. Hg (101 kPa) atmospheric pressure (corrected to sea level) for an elevation up to 2000 feet (600 m).

28.2.5 Vacuum.

28.2.5.1 If the completed pumping system is capable of taking suction per 28.2.3, it shall be capable of developing a vacuum of 17 in. Hg (57.4 kPa) at altitudes up to 2000 ft (600 m) by means of the pump priming system and sustaining the vacuum for at least 5 minutes with a loss not to exceed 10 in. Hg (34 kPa).

28.2.5.2 The requirements of 28.2.5.1 shall be met with all intake valves open, with all intakes capped or plugged, with all discharge caps removed and valves closed, and without the use of the pump primer during the 5-minute period.

28.3 Power Train Capability.

28.3.1 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 30 minutes at the pump's rated capacity and pressure.

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

28.4 Construction Requirements.

28.4.1 The pump body, discharge piping, and valves, excluding the tank fill lineon the tank side of the valve, shall be capable of withstanding a minimum hydrostatic pressure of 1.4 times the rated discharge pressure.

28.4.2 The pump intake, tank fill line on the tank side of the valve, and associated plumbing and valves, excluding the tank-to-pump line on the tank side of the valve, shall be capable of withstanding a minimum hydrostatic pressure of 250 psi (1700 kPa).

28.4.3 The pump, piping, and valves shall be capable of delivering the rated capacity at the rated discharge pressure of the pump and withstanding closure of all discharges.

28.4.4 Pump Body Integrity Test. The pump body shall be subjected to either a hydrostatic test per 28.4.4.1 or a hydrodynamic test per 28.4.4.2.

28.4.4.1 If the pump body is subjected to a hydrostatic test, it shall be hydrostatically tested to a gauge pressure of 1.4 times the rated discharge pressure for a minimum of 10 minutes.

28.4.4.2 If the pump body is subjected to a hydrodynamic test, it shall be hydrodynamically tested to a gauge pressure of 1.4 times the rated discharge pressure for a minimum of 10 minutes.

28.4.4.3 The pump manufacturer shall provide a certificate of completion for the hydrostatic or hydrodynamic test.

28.5 Pump Intakes.

28.5.1 Each pump intake shall be sized to permit the full rated performance of the pump.

28.5.2* For any pump intake equipped with a valve, the valve shall be controlled from the pump operator's position.

28.5.3* Each external intake shall be equipped with National Hose (NH) threads on the connection with a removable or accessible strainer.

28.5.3.1 Adapters with special threads or other means for hose attachment shall be permitted on any intake connection.

28.5.3.2 Each external valved intake larger than 1 ½ in. shall be equipped with a bleeder valve to bleed off air or water from a hose connected to the intake.

28.5.3.3 All intake connections shall be provided with closures, caps, or plugs capable of withstanding a hydrostatic gauge pressure of 250 psi (1730 kPa).

28.5.3.3.1 Intake connections having male threads shall be equipped with caps.

28.5.3.3.2 Intake connections having female threads shall be equipped with plugs.

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

28.5.3.4 Caps or closures for intake connections 3 in. (75 mm) and smaller shall remain secured to the apparatus when removed from the connection.

28.5.4 The pump shall have a means to restrict debris that is too large to pass through the pump.

28.6 Pump Discharges.

28.6.1* Each pump discharge shall be equipped with a valve that can be controlled from a pump operator's position.

28.6.2 Any discharge that can be supplied from another pump system on the apparatus shall have check valves in both supply lines to prevent backflow into either pump.

28.6.3 Discharge Outlet Connections.

28.6.3.1 All discharge outlets, except connections to which a hose will be preconnected, shall be equipped with connectors that permit hose attachment or removal within 30 seconds.

28.6.3.2 Adapters with special threads or other means for hose attachment shall be permitted to be attached to any discharge outlet connection.

28.6.3.3 Discharge outlet connections shall not be permitted to be equipped with NH threads.

28.6.4 All discharge outlet connections, except connections to which a hose will be preconnected, shall be equipped with caps or closures capable of withstanding a hydrostatic gauge pressure of 1.4 times the rated discharge pressure.

28.6.4.1 If the apparatus has more than one discharge, the caps or closures shall be capable of withstanding closure of all discharges when pump controls are set to deliver rated capacity at rated discharge pressure.

28.6.4.2 Where adapters are provided on the discharge outlet connection, the closures shall fit on the adapters.

28.6.4.3 Caps or closures for outlet connections 3 in. (75 mm) and smaller shall remain secured to the apparatus when removed from the connection.

28.6.5 All preconnected hose connections and preconnected hoses shall be capable of withstanding a hydrostatic gauge pressure of 1.4 times the maximum discharge pressure.

28.6.6 All preconnected hose connections and preconnected hoses shall be capable of withstanding closure of all discharges when pump controls are set to deliver rated capacity at rated discharge pressure.

28.6.7* If a water tank fill line is provided, the line shall be connected from the pump discharge manifold directly to the water tank.

28.6.8 If a water tank fill line is provided, the line shall include a valve that can be controlled from the pump operator's position.

28.7 Pump Operator's Panel.

28.7.1 Each pump control, gauge, and other instrument necessary to operate the ultra-high pressure fire pump shall be marked with a label as to its function.

28.7.2 All gauges, instruments, and controls located on the ultra-high pressure fire pump operator's panel shall be illuminated to a minimum lighting level of 5 fc (54 lx).

28.7.3 Safety sign FAMA25, which warns of the need for training prior to operating the apparatus, shall be located on the pump operator's panel.

28.7.4 Safety sign FAMA20, which warns of the hazards of ultra-high pressure, shall be located in a visible location adjacent to any discharge outlet.

28.8 Pump Controls.

28.8.1* Controls shall be provided for placing the pump in operation.

28.8.2 If the pump requires engagement to operate, the control for the pump engagement mechanism shall be marked with a label to indicate when the pump is properly engaged in pumping position.

28.8.3 Pressure Control System.

28.8.3.1 A system shall be provided or the pump shall have operating characteristics that are capable of limiting the increase of net pump pressure to a maximum pressure rise of 40 percent over the rated pump pressure when all discharges are closed when the engine and pump controls are set to

produce the rated capacity at the rated net pump pressure of the pump.

28.8.3.2 If the pump is equipped with a governor system that controls engine speed, an indicator shall show when the system is turned on and whether it is controlling the engine speed or pump pressure.

28.8.3.3 If the pump is equipped with a governor system, it shall be controllable by one person at the pump operator position.

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

28.8.5 Drain Valve(s).

28.8.5.1 An accessible drain valve(s) that is marked with a label as to its function shall be provided to allow the pump and all water-carrying lines and accessories to be drained.

28.8.5.2 The drain valve(s) shall be operational without the operator having to get under the apparatus.

28.8.6 Pump Cooling.

28.8.6.1* A pump cooling/recirculation line of sufficient size to prevent the pump from overheating when no discharge lines are open shall be provided between the pump discharge and the water tank.

28.8.6.2 Where the pump is of a positive displacement type an automatic bypass relief valve shall be permitted to be provided in place of the recirculation line.

28.9 Pump Drive Systems.

28.9.1 Where the pump is driven by a split-shaft PTO transmission, chassis transmission-mounted (SAE) PTO, front-of-engine crankshaft PTO, or flywheel PTO, the provisions of 16.10.2 through 16.10.6 shall apply as applicable.

28.9.2 Where the pump is driven by a chassis transmission-mounted (SAE) PTO and the pump system does not conform to 16.4.2, a visible or audible warning device shall be provided on the pump operator's panel that is actuated if the temperature of the lubricant in the chassis transmission exceeds the transmission manufacturer's recommended maximum temperature.

28.9.3 If a separate pumping engine is provided, it shall meet the requirements of 12.2.1.1, 12.2.1.2, 12.2.1.7, 12.2.2, 12.2.3.1, 12.2.3.2, 12.2.4, 12.2.5, 12.2.6, Section 13.2, 13.4.3, 13.4.4, 13.4.4.1, 13.4.4.3, 13.4.4.4, 13.4.5, and Section 13.5.

28.10* Engine Controls.

28.10.1 A throttle control shall be provided to control the engine speed.

28.10.2 This throttle control shall be permitted to be the same throttle control that is used for the main fire pump.

28.11 Gauges and Instruments.

28.11.1 Master Pump Discharge Pressure Gauge. A master discharge pressure gauge shall be provided.

28.11.1.1 The master discharge pressure gauge shall read from a gauge pressure of 0 to not less than 500 psi (3500 kPa) higher than the maximum pressure that can be developed by the pump when it is operating with zero intake pressure.

28.11.1.2 Where an analog pressure gauge is used, it shall have a minimum accuracy of Grade 1A as defined in ASME B40.100, *Pressure Gauges and Gauge Attachments*.

28.11.1.2.1 Numerals for master gauges shall be a minimum 0.25 in. (6.4 mm) high.

28.11.1.2.2 There shall be graduation lines showing at least every 50 psi (200 kPa), with major and intermediate graduation lines emphasized and figures at least every 500 psi (2000 kPa).

28.11.1.2.3 Analog pressure gauges shall be vibration and pressure pulsation dampened; be resistant to corrosion, condensation, and shock; and have internal mechanisms that are factory lubricated for the life of the gauge.

28.11.1.3 If a digital pressure gauge is used, the digits shall be at least 0.25 in. (6.4 mm) high.

28.11.1.3.1 Digital pressure gauges shall display pressure in increments of not more than 50 psi (200 kPa).

28.11.1.3.2 Digital master pressure gauges shall have an accuracy of ±3 percent over the full scale.

28.11.2 Protection of Gauges and Instruments. Each pressure gauge or flowmeter and its respective display shall be mounted and attached so it is protected from accidental damage and excessive vibration.

28.11.3* Cab Gauges. If the apparatus is designed for pump-and-roll operations, a second gauge that meets the same requirements as the discharge pressure gauge required by 28.11.1 shall be mounted in the driving compartment in view of the driver.

28.12 Required Testing.

28.12.1 Apparatus Pump System Certification.

28.12.1.1 General. The UHP pump shall be tested after the pump and all its associated piping and equipment have been installed on the fire apparatus.

28.12.1.1.1 The testing shall include at least the 30-minute pumping test in 28.12.5, the pressure control test in 28.12.7, the gauge and flowmeter test in 28.12.11, the manufacturer's predelivery test in 28.12.12, the and the water tank capacity test in 28.12.13.

28.12.1.1.2 If the 30-minute pumping test is not performed from the apparatus water tank, the water tank–to–pump flow test in 28.12.6 shall be included.

28.12.1.1.3 If the pumping system is equipped with a priming system, the priming system test in 28.12.8 and the vacuum test in 28.12.9 shall be included.

28.12.1.1.4 If the UHP pump is driven by the chassis engine, the engine speed advancement interlock test in 28.12.10 shall be included.

28.12.1.1.5 The test results shall be certified by the manufacturer.

28.12.1.2* Test Label.

28.12.1.2.1 A test label shall be provided at the pump operator's position that gives the rated discharges and pressures.

28.12.1.2.2 If powered by an engine, the speed of the engine as determined by the certification test for each unit and the governed speed of the engine as stated by the engine manufacturer on a certified brake horsepower curve shall be provided on the test label.

28.12.1.2.3 The label shall be stamped with all information at the factory and attached to the vehicle prior to shipping.

28.12.2 Conditions for Tests.

28.12.2.1 Tests shall be performed when conditions are as follows:

(1) Air temperature: 0°F to 110°F (–18°C to 43°C)
(2) Water temperature: 35°F to 90°F (2°C to 32°C)
(3) Barometric pressure: 29 in. Hg (98.2 kPa), minimum (corrected to sea level)

28.12.2.2 If it is necessary to perform the test outside the air or water temperature ranges or the minimum barometric pressure stated in 28.12.2.1 and the pump passes the certification test, the test results shall be acceptable.

28.12.2.3 Engine-driven accessories shall not be functionally disconnected or otherwise rendered inoperative during the tests.

28.12.2.3.1 If the chassis engine drives the UHP pump, the total continuous electrical loads, excluding those loads associated with the equipment defined in 28.12.2.3.3, shall be applied for the entire pumping portion of this test.

28.12.2.3.2 If the vehicle is equipped with a fixed power source driven by the same engine that drives the ultra-high pressure fire pump, the fixed power source shall be running at a minimum of 50 percent of its rated capacity throughout the pumping portion of the pump test.

28.12.2.3.3 The following devices shall be permitted to be turned off or not operating during the pump test:

(1) Foam pump
(2) Hydraulically driven equipment (other than hydraulically driven line voltage generator)
(3) Winch
(4) Windshield wipers
(5) Four-way hazard flashers
(6) Compressed air foam system (CAFS) compressor

28.12.2.3.4 All structural enclosures, such as floorboards, gratings, grilles, and heat shields not furnished with a means for opening them in normal service shall be kept in place during the tests.

28.12.3 Equipment.

28.12.3.1 One or more lines of UHP hose of sufficient diameter shall be provided to allow discharge of the rated capacity of the pump without exceeding a flow velocity of 35 ft/sec (10.7 m/sec) through the hose.

28.12.3.2 Discharge rate shall be measured using equipment such as flowmeters, volumetric tanks, or weigh tanks.

28.12.3.3 Test Gauges.

28.12.3.3.1 All test gauges shall meet the requirements for Grade A gauges as defined in ASME B40.100 and shall be at least size 3½ per ASME B40.100, *Pressure Gauges and Gauge Attachments*.

28.12.3.3.2 The pump intake 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 a gauge pressure of 150 psi (1000 kPa) for a compound gauge.

28.12.3.3.3 The discharge pressure gauge shall have a gauge pressure range of 0 psi (0 kPa) to not less than 500 psi (3500 kPa) over the rated pump discharge pressure.

28.12.3.3.4 All gauges shall have been calibrated in the year preceding the tests using a deadweight gauge tester or a master gauge meeting the requirements for Grade 3A or Grade 4A gauges, as defined in ASME B40.100, that has been calibrated within the preceding year.

28.12.3.3.5 Each test gauge connection shall include a means for snubbing, such as a needle valve to damp out rapid needle movements.

28.12.3.4 Speed-measuring equipment shall consist of a tachometer or other device for measuring revolutions per minute.

28.12.4 Procedure.

28.12.4.1* The ambient air temperature, water temperature, elevation of test site, and atmospheric pressure (corrected to sea level) shall be determined and recorded prior to the pump test.

28.12.4.2* The engine, pump, transmission, and all parts of the fire apparatus shall exhibit no undue heating, loss of power, overspeed, leaks, or other defect during the entire test.

28.12.5 Thirty-Minute Pumping Test.

28.12.5.1 The UHP pump shall be subjected to a 30-minute pumping test consisting of continuous pumping at rated capacity at rated pump discharge pressure.

28.12.5.2 The 30-minute pumping test shall be permitted to be performed from the apparatus water tank with provisions to maintain tank level during the duration of the test.

28.12.5.3 The 30-minute pumping test shall be permitted to be performed with water supplied to the pump intake from a separate water supply that provides positive pressure to the pump intake.

28.12.5.4 If the 30-minute pumping test is performed with water supplied to the pump that provides positive pressure at the pump intake, the net pump pressure shall be equal to the rated pump discharge pressure.

28.12.5.5 The 30-minute pumping test shall be permitted to be run at a test site that provides a supply of clear water and is 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 a minimum of 10 ft (3 m) of suction hose.

28.12.5.6 If the pump is stopped before the test is completed, the entire pump test shall be repeated.

28.12.5.7* The flow discharge pressure, intake pressure, and engine speed shall be recorded at least every 15 minutes but not fewer than three times for each test sequence.

28.12.5.8 The average net pump pressure shall be calculated and recorded based on the average values for discharge and intake pressure.

28.12.6 Water Tank–to–Pump Flow Test.

28.12.6.1 If the 30-minute pumping test in 28.12.5 is not performed from the apparatus water tank, a water tank–to–pump flow test shall be performed with water supplied from the apparatus water tank to verify the tank to pump flow capability.

28.12.6.2 The test shall consist of 5 minutes of continuous pumping at rated capacity at rated pump pressure taking water from the apparatus water tank.

28.12.6.3 The flow, discharge pressure, and engine speed shall be recorded at the beginning and end of the test.

28.12.7 Pressure Control Test. The pressure control system of an ultra-high pressure fire pump shall be tested for pressure rise as follows:

(1) The ultra-high pressure fire pump shall be operated to deliver rated capacity at rated discharge gauge pressure.
(2) If a pressure control system is supplied, it shall be set in accordance with the manufacturer's instructions.
(3) All discharge valves shall be closed.
(4) Any rise in discharge pressure shall not exceed 40 percent of the rated discharge pressure.
(5) The pump shall be operated with the discharge lines closed for 3 minutes without the temperature of the pump exceeding 140°F (60°C).
(6)* The final discharge pressure, any rise in discharge pressure, and the final pump temperature shall be recorded.

28.12.8 Priming System Test. If the UHP pumping system is equipped with a priming system, it shall be operated in accordance with the manufacturer's instructions until the pump has been primed and is discharging water.

28.12.8.1* This test shall be run at a test site that provides a supply of clear water and is close enough to allow 10 ft (3 m) of suction hose of the size specified in Table 28.2.3 and equipped with a suction hose strainer to be connected to the pump intake to be submerged at least 2 ft (0.6 m) below the surface of the water, with the water level at least 3 ft (0.91 m) below the center of the pump intake corrected for the following conditions:

(1) At an altitude of 2000 ft (600 m) above sea level
(2) At 29.9 in. Hg (101 kPa) atmospheric pressure (corrected to sea level)
(3) At a water temperature of 60°F (16°C)

28.12.8.2 The interval from the time the priming system is started until the time the pump is discharging water shall be noted.

28.12.8.3 The time required to prime the pump shall not exceed 30 seconds.

28.12.8.4 Only biodegradable products shall be permitted to be discharged onto the ground.

28.12.9 Vacuum Test. If the UHP pumping system is equipped with a priming system, a vacuum test shall be performed that consists of subjecting the interior of the pump, with all intake valves open, with all intakes capped or plugged, and with all discharge caps removed, to a vacuum of 17 in. Hg (57.6 kPa) by means of the pump priming system.

28.12.9.1 At altitudes above 2000 ft (600 m), the vacuum attained shall be permitted to be less than 17 in. Hg (57.6 kPa) by 1 in. Hg (3.4 kPa) for each 1000 ft (300 m) of altitude above 2000 ft (600 m).

28.12.9.2 The primer shall not be used after the 5-minute test period has begun.

28.12.9.3 The engine shall not be operated at any speed greater than the governed speed during this test.

28.12.9.4 The vacuum shall not drop more than 10 in. Hg (34 kPa) in 5 minutes.

28.12.9.5 The vacuum test shall then be repeated with all intake valves closed and the caps or plugs on all gated intakes removed.

28.12.10* Engine Speed Advancement Interlock Test. If the UHP pump is driven by the chassis engine, the engine speed advancement interlock system shall be tested to verify that engine speed cannot be increased at the pump operator's panel unless there is throttle-ready indication.

28.12.10.1 If the apparatus is equipped with a stationary UHP pump driven through a split shaft PTO, the test shall verify that the engine speed control at the pump operator's panel cannot be advanced when either of the following conditions exists:

(1) The chassis transmission is in neutral, the parking brake is off, and the UHP pump shift in the driving compartment is in the road position.
(2) The chassis transmission has been placed in the position for pumping as indicated on the label provided in the driving compartment, the parking brake is on, and the UHP pump shift in the driving compartment is in the road position.

28.12.10.2 If the apparatus is equipped with a stationary UHP pump driven through a transmission-mounted PTO, front-of-engine crankshaft PTO, or engine flywheel PTO, the test shall verify that the engine speed control on the pump operator's panel cannot be advanced when either of the following conditions exists:

(1) The chassis transmission is in neutral, the parking brake is off, and the UHP pump shift status in the driving compartment is disengaged.
(2) The chassis transmission is in any gear other than neutral, the parking brake is on, and the UHP pump shift in the driving compartment is in the "Pump Engaged" position.

28.12.10.3 If the apparatus is equipped with a UHP pump driven by the chassis engine designed for both stationary pumping and pump-and-roll, the test shall verify that the engine speed control at the pump operator's panel cannot be advanced when any of the following conditions exists:

(1) The chassis transmission is in neutral, the parking brake is off, and the UHP pump shift status in the driving compartment is disengaged.
(2) The chassis transmission is in any gear other than neutral, the parking brake is on, and the UHP pump shift in the driving compartment is in the "Pump Engaged" position.
(3) The chassis transmission is in any gear other than neutral, the parking brake is off, the UHP pump shift in the driving compartment is in the "Pump Engaged" position, and the "OK to Pump-and-Roll" indicator is on.

28.12.10.4 If the apparatus is equipped with a stationary UHP pump driven through a transfer case PTO, the test shall verify that the engine speed control on the pump operator's panel

cannot be advanced when one of the following conditions exists:

(1) The chassis transmission is in neutral, the transfer case is in neutral, the parking brake is off, and the UHP pump shift in the driving compartment is in the road position.
(2) The chassis transmission is in neutral, the transfer case is engaged, the parking brake is off, and the UHP pump shift in the driving compartment is in the road position.
(3) The chassis transmission has been placed in the position for pumping as indicated on the label provided in the driving compartment, the parking brake is on, and the UHP pump shift in the driving compartment is in the road position.

28.12.11 Gauge and Flowmeter Test.

28.12.11.1 Pump intake and discharge pressure gauges shall be checked for accuracy while pumping at rated capacity at pump rated pressure.

28.12.11.2 Any gauge that does not meet Grade B ASME B40 requirements as compared to the calibrated test gauge shall be recalibrated, repaired, or replaced.

28.12.11.3 Each flowmeter shall be checked for accuracy while pumping at rated capacity at pump rated pressure.

28.12.11.4 Any flowmeter that is off by more than 10 percent shall be recalibrated, repaired, or replaced.

28.12.12 Manufacturer's Predelivery Test.

28.12.12.1 Piping Integrity Test. The UHP pump and its connected piping system shall be subjected to both a hydrostatic test per 28.12.12.2and a hydrodynamic test per 28.12.12.3.

28.12.12.2 Hydrostatic Test. All system plumbing that will be exposed to rated pump discharge pressure shall be hydrostatically tested to at least 1.4 times the rated pump discharge pressure.

28.12.12.2.1 The following system components shall not be required to be hydrostatically tested under this section:

(1) Pump intake plumbing
(2) Portions of a discharge path that vent to atmosphere
(3) The pump body and any permanently mounted plumbing supplied by the pump manufacturer

28.12.12.2.2 If the complete plumbing system is capable of withstanding the hydrostatic test pressure, or if the items listed in 28.12.12.2.1 can be isolated from hydrostatic test pressure through the use of permanently installed valves, the test procedure shall be as follows:

(1) Establish the system boundaries by shutting all valves to components listed in 28.12.12.2.1. All other valves must be open with the discharge outlet capped, plugged, flanged, or otherwise sealed.
(2) Fill the system with water and bleed all air from the system.
(3) Use a hydrostatic test pump to establish a test pressure of at least 1.4 times the rated pump discharge pressure.
(4) Maintain the hydrostatic test pressure for at least 3 minutes.

28.12.12.2.3 If the design of the system will not allow the components listed in 28.12.12.2.1 to be isolated from hydrostatic test pressure when installed on the completed apparatus, and such components are not designed to withstand hydrostatic test pressure, the hydrostatic test shall be permitted to be performed on the discharge plumbing prior to installation on the apparatus.

28.12.12.2.3.1 The plumbing connections that connect to the components listed in 28.12.12.2.1 shall be capped or plugged during the hydrostatic test.

28.12.12.2.3.2 Once the section is isolated, the test procedure shall be as listed in 28.12.12.2.2(2) through 28.12.12.2.2(4).

28.12.12.3 As installed on the apparatus, all piping that will be exposed to rated pump discharge pressure shall be hydrodynamically tested.

28.12.12.3.1 The test procedure shall be as follows:

(1) Establish the system boundaries by shutting all discharge valves
(2) Establish a water supply to the UHP pump, either from the tank or from an external source
(3) Fill the system with water and bleed all air from the system
(4) Use the UHP pump to establish the maximum pump discharge pressure without disabling relief valves, governors, or automatic shutdown systems
(5)* Conduct the hydrodynamic test, which can be conducted with a bypass valve, relief valve, or discharge valve open as necessary to maintain pump temperature during the test
(6) Maintain the hydrodynamic test pressure for a minimum of 5 minutes
(7) Verify there is no leakage in any of the plumbing

28.12.12.3.2 The hydrodynamic test in 28.12.12.3.1 shall be permitted to be performed in conjunction with the 30-minute pumping test in 28.12.5.

28.12.13 Water Tank Capacity Test. The water tank shall be tested for usable water capacity by either a totalizing flowmeter method or truck weight method.

28.12.13.1 The water tank shall be filled until it overflows.

28.12.13.2 If the unit is equipped with an automatic shutdown due to a low pressure feature, the feature shall be engaged.

28.12.13.3 If a totalizing flowmeter is used, the meter shall be connected to a discharge and set to zero.

28.12.13.3.1 If the totalizing flowmeter is connected to a discharge valve, the valve shall be opened and the unit run at between 50 and 100 percent of the pump's rated flow until it automatically shuts down or the pressure drops below 1000 psi (7000 kPa).

28.12.13.3.2 The total volume that was discharged shall be recorded.

28.12.13.4 If the truck weight method is used, the truck shall be weighed and the weight recorded.

28.12.13.4.1 The pump shall be started and brought up to a flow rate of between 25 percent and 35 percent of the pump's rated flow by partly opening a discharge valve or by reducing the speed of the pump.

28.12.13.4.2 The discharge valve shall be closed when the unit automatically shuts down or the pump pressure drops below 1000 psi (7000 kPa).

28.12.13.4.3 The truck shall be reweighed.

28.12.13.4.4 The water tank empty weight shall be subtracted from water tank full weight and the result divided by 8.33 lb/gal to obtain the usable water volume in gallons.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1 The term *new* as applied in this standard is intended to refer to the original construction of a fire apparatus using all new materials and parts.

A.1.3.1 The requirements of this standard apply to fire apparatus that have a GVWR of 10,000 lb (4500 kg) or greater. While the standard was not written specifically to cover vehicles below that size, fire departments should consider using those portions of this standard that address safety issues with smaller emergency vehicles. This would apply particularly to the restraint of equipment in the driving and crew areas and to providing adequate optical warning devices and reflective striping to increase the visibility of the vehicle.

A.1.4 It is not intended that this standard be applied retroactively to existing apparatus. However, if major renovations are made to an existing piece of apparatus, it is suggested that the apparatus be brought into line with this standard as closely as possible. NFPA 1912 covers the requirements for refurbishing a fire apparatus.

A.1.6.1 Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). The liter, a unit that is outside of but recognized by SI, is commonly used in international fire protection. Table A.1.6.1(a) and Table A.1.6.1(b) provide U.S.-to-SI conversion factors and SI-to-U.S. conversion factors as an aid to the user. Table A.1.6.1(c) provides other conversion factors that could be useful to the reader. Table A.1.6.1(d) provides a list of the abbreviations used in this standard and their meanings.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

Table A.1.6.1(a) Conversion Factors: U.S. Units to SI Units

U.S. Units		SI Units
1 gallon per minute (gpm)	=	3.785 liters per minute (L/min)
1 imperial gallon per minute (igpm)	=	4.546 liters per minute (L/min)
1 pound per square inch (psi)	=	6.895 kilopascals (kPa)
1 inch of mercury (in. Hg) at 60°F (15.6°C)	=	3.377 kilopascals (kPa)
1 inch (in.)	=	25.40 millimeters (mm)
1 foot (ft)	=	0.305 meter (m)
1 cubic foot (ft^3)	=	0.0283 cubic meter (m^3)
1 square inch ($in.^2$)	=	645.2 square millimeters (mm^2)
1 mile per hour (mph)	=	1.609 kilometers per hour (km/hr)
1 pound (lb)	=	0.454 kilogram (kg)
1 horsepower (hp)	=	0.746 kilowatt (kW)
1 candlepower (cp)	=	12.566 lumens
1 pound per cubic foot (lb/ft^3)	=	16 kilograms per cubic meter (kg/m^3)
1 footcandle (fc)	=	10.764 lux (lx)
1 footlambert	=	3.427 candela/m^2

Table A.1.6.1(b) Conversion Factors: SI Units to U.S. Units

SI Units		U.S. Units
1 liter per minute (L/min)	=	0.264 gallon per minute (gpm)
1 liter per minute (L/min)	=	0.22 imperial gallon per minute (igpm)
1 kilopascal (kPa)	=	0.145 pound per square inch (psi)
1 kilopascal (kPa)	=	0.2962 in. Hg at 60°F (15.6°C)
1 millimeter (mm)	=	0.0394 inch (in.)
1 meter (m)	=	3.281 feet (ft)
1 cubic meter (m^3)	=	35.31 cubic feet (ft^3)
1 square millimeter (mm^2)	=	0.00155 square inch ($in.^2$)
1 kilometer per hour (km/hr)	=	0.6214 mile per hour (mph)
1 kilogram (kg)	=	2.2 pounds (lb)
1 kilowatt (kW)	=	1.34 horsepower (hp)
1 lumen	=	0.08 candlepower (cp)
1 kilogram per cubic meter (kg/m^3)	=	0.062 pound per cubic foot (lb/ft^3)
1 lux (lx)	=	0.092 footcandle (fc)
1 candela/m^2	=	0.292 footlambert

Table A.1.6.1(c) Other Useful Conversion Factors

1 gallon per minute (gpm)	=	0.833 imperial gallon per minute (igpm)
1 imperial gallon per minute (igpm)	=	1.2 gallons per minute (gpm)
1 foot (ft) of water	=	0.433 pound per square inch (psi)
1 pound per square inch (psi)	=	2.31 feet (ft) of water
1 metric ton (mton)	=	1000 kilograms (kg)
1 kilopascal (kPa)	=	0.01 bar
1 bar	=	100 kilopascals (kPa)

Table A.1.6.1(d) Abbreviations Used in This Standard

Abbreviation	Term
A	ampere(s)
ac	alternating current
C	Celsius
cd	candela(s)
dc	direct current
F	Fahrenheit
fc	footcandle(s)
ft	foot (feet)
gpm	gallon(s) per minute
hp	horsepower
in.	inch(es)
in. Hg	inch(es) of mercury
kg	kilogram(s)
km/hr	kilometer(s) per hour
kPa	kilopascal(s)
kW	kilowatts(s)
L	liter(s)
L/min	liter(s) per minute
lx	lux
m	meter(s)
mm	millimeter(s)
mph	mile(s) per hour
NH	National Hose
psi	pound(s) per square inch
rms	root mean square
V	volt(s)

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations 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.

A.3.3.10 Air Tank. Air tanks might be designated as cylinders, receivers, or vessels.

A.3.3.41 Compound Gauge. On most gauges, zero equals atmospheric pressure. Gauges typically measure pressure above atmospheric pressure in pounds per square inch (psi) [kilopascals (kPa)] and below atmospheric pressure in inches of mercury (in. Hg) [kilopascals (kPa)].

A.3.3.42 Compressed Air Foam System (CAFS). A CAFS consists of a compressed air source, pressurized source of foam solution, and discharge hardware.

A.3.3.46 Contractor. The contractor might not necessarily manufacture the fire apparatus or any portion of the fire apparatus but is responsible for the completion, delivery, and acceptance of the entire unit.

A.3.3.57 Eductor. The pressure at the throat of a venturi is below atmospheric pressure, allowing foam concentrate or other fire-fighting agent at atmospheric pressure in storage to flow into the water stream.

A.3.3.58 Electric Siren (Electromechanical). Only one type of warning sound can be produced by electric sirens, but the level or pitch can be varied by the speed of the motor.

A.3.3.60 Electronic Siren. Varied types of warning sounds can be produced by electronic sirens, such as a wail, yelp, or simulated air horn.

A.3.3.81 GAWR (Gross Axle Weight Rating). It is a requirement of the National Highway Traffic Safety Administration (NHTSA) that the GAWR be posted in the vehicle on a permanently affixed label. The axle system includes, but is not limited to, the axle, tires, suspension, wheels, frame, brakes, and applied engine torque.

A.3.3.82 GCWR (Gross Combination Weight Rating). A combination vehicle is the combination of a towing vehicle and one or more towed units (trailers). When a trailer is detachable, the GCWR limits the maximum loaded weight for any replacement trailer. The in-service weight or gross combination weight, including any connected trailer, should always be equal to or less than the GCWR.

A.3.3.84 Grade. A 45-degree slope is equal to a 100-percent grade.

A.3.3.86 Ground-Fault Circuit Interrupter (GFCI). Class A ground-fault circuit interrupters trip when the current to ground is 6 mA or higher and do not trip when the current to ground is less than 4 mA. For further information, see UL 943, *Standard for Ground-Fault Circuit Interrupters.* [**70:**100]

A.3.3.88 GVWR (Gross Vehicle Weight Rating). It is a requirement of the National Highway Traffic Safety Administration (NHTSA) that the GVWR of a vehicle be posted in the vehicle on a permanently affixed label. The GVWR can be equal to or less than the sum of the front GAWR and the rear GAWR. The in-service weight or gross vehicle weight should always be equal to or less than the GVWR.

A.3.3.111 Maximum Pump Close-Off Pressure. Multistage series/parallel pumps are measured with the pump in the pressure (series) setting.

A.3.3.120 Net Pump Pressure. When operating from a hydrant, the net pump pressure typically is less than the discharge pressure. For example, if the discharge pressure gauge reads 150 psi (1034 kPa) and the intake (suction) gauge reads 20 psi (138 kPa), the net pump pressure equals 130 psi (896 kPa). When operating from draft, the net pump pressure will be above the discharge pressure. For example, if the discharge pressure gauge reads 145 psi (1000 kPa) and the intake (suction) gauge reads 10 in. Hg (34 kPa) vacuum, the net pump pressure will be 150 psi (1034 kPa) (1 in. Hg = 0.5 psi = 3.4 kPa).