

NFPA 1906

Standard for Wildland Fire Apparatus

2006 Edition



NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
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Standard for

Wildland Fire Apparatus

2006 Edition

This edition of NFPA 1906, *Standard for Wildland Fire Apparatus*, was prepared by the Technical Committee on Fire Department Apparatus.

It was issued by the Standards Council on January 27, 2006, with an effective date of February 16, 2006, and supersedes all previous editions.

This edition of NFPA 1906 was approved as an American National Standard on February 16, 2006.

Origin and Development of NFPA 1906

The first edition of NFPA 1906, *Standard for Wildland Fire Apparatus*, was published in 1995 to provide a standard for apparatus that are basically designed and deployed to combat fires in wildland. The document covered apparatus with pumps ranging in size from 20 gpm to 250 gpm (76 L/min to 950 L/min) and water tanks with a capacity of 125 gal (473 L) or more.

Requirements were also provided for the first time for foam proportioning systems using Class A foam as a fire suppressant agent and for Compressed Air Foam Systems (CAFS). The apparatus covered in the standard included built-to-specification apparatus and fire-fighting packages designed to be slipped onto a vehicle chassis.

In the 2001 edition, the requirements for low-voltage electrical systems, including the emergency warning systems, were brought in line with the requirements in NFPA 1901, *Standard for Automotive Fire Apparatus*. The chapter on pumps was reorganized to provide requirements for four types of pumps, with the range of sizes changed to include pumps from 10 gpm (38 L/min) to 500 gpm (1900 L/min). The allowable minimum size on water tanks was lowered to 50 gal (190 L), and the chapter on line-voltage systems was removed. The document was also updated in other areas where appropriate to make the requirements consistent with those in NFPA 1901.

This 2006 edition is a general updating of the document, including making requirements consistent with those in NFPA 1901 when appropriate. It adds requirements for what the manufacturer certification of test results must include, and for better illumination and signage for controls, switches, instruction plates, gauges, and instruments. This edition also introduces the concept of estimated in-service weight as a basis for measuring certain stability requirements and links the maximum top speed of the apparatus to the tire manufacturer's ratings. It also requires more head height at seating positions and the use of red seat belts if available.

The 2006 edition also reorganizes the requirements for water pumps installed on the wildland fire apparatus into seven categories and updates the requirements for baffling water tanks to better address smaller water tanks. The standard requires type testing of foam systems followed by individualized testing of each installation. Two additional annexes were added, one to provide an equipment size and weight chart, the other to provide guidelines for first-line and reserve fire apparatus.

Finally, the document has been reorganized according to the *Manual of Style for NFPA Technical Committee Documents*.

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Committee Scope: This Committee shall have primary responsibility for documents on the design and performance of fire apparatus for use by the fire service.

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A reference in brackets [] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex E. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex E.

Chapter 1 Administration

1.1* Scope. This standard defines the requirements for new automotive fire apparatus, including apparatus equipped with a slip-on fire-fighting module, designed primarily to support wildland fire suppression operations.

1.2 Purpose. This standard specifies the minimum requirements for a new automotive wildland fire apparatus.

1.3 Application.

1.3.1* This standard shall apply to new fire apparatus that meet the following criteria:

- (1) Designed specifically for supporting wildland fire suppression operations
- (2) Contracted for on or after July 1, 2006

1.3.2 Nothing shall prevent the use of the standard prior to July 1, 2006 if the purchaser and contractor agree.

1.3.3 If the primary purpose of the apparatus is to support structural fire fighting or associated fire department operations, the requirements of NFPA 1901, *Standard for Automotive Fire Apparatus*, shall apply.

1.4* Retroactivity. The standard is not intended to be applied retroactively.

1.5 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.5.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.5.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.6* Units of Measure. In this standard, values for measurement in U.S. units are followed by an equivalent in SI units. Either set of values can be used, but the same set of values (either U.S. units or SI units) shall be used consistently.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1901, *Standard for Automotive Fire Apparatus*, 2003 edition.

NFPA 1961, *Standard on Fire Hose*, 2002 edition.

NFPA 1963, *Standard for Fire Hose Connections*, 2003 edition.

2.3 Other Publications.

2.3.1 ASME Publications. American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 and Division 2, 2004.

ASME B1.20.7, *Hose Coupling Screw Threads, Inch*, 1991.

ASME B40.100, *Pressure Gauges and Gauge Attachments*, 1998.

2.3.2 ASTM Publications. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 4956, *Standard Specification for Retroreflective Sheeting for Traffic Control*, 2005.

ASTM F 1677, *Standard Test Method for Using a Portable Inclined Articulated Strut Slip Tester (PIAST)*, 2005.

ASTM F 1679, *Standard Test Method for Using a Variable Incidence Tribometer (VIT)*, 2004.

2.3.3 NEMA Publication. National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1847, Rosslyn, VA 22209.

NEMA Z535.4, *Standard for Product Safety Signs and Labels*, 2002.

2.3.4 SAE Publications. Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

SAE J156, *Fusible Links*, 2000.

SAE J541, *Voltage Drop for Starting Motor Circuits*, 1996.

SAE J551/2, *Test Limits and Methods of Measurement of Radio Disturbance Characteristics of Vehicles, Motorboats, and Spark-Ignited Engine-Driven Devices*, 1994.

SAE J553, *Circuit Breakers*, 2004.

SAE J554, *Electric Fuses (Cartridge Type)*, 1987.

SAE J578, *Color Specification*, 2002.

SAE J595, *Directional Flashing Optical Warning Devices for Authorized Emergency, Maintenance, and Service Vehicles*, 2005.

SAE J683, *Tire Chain Clearance — Trucks, Buses (except Suburban, Intercity, and Transit Buses), and Combinations of Vehicles*, 1985.

SAE J833, *Human Physical Dimensions*, 1989.

SAE J845, *360 Degree Warning Devices for Authorized Emergency, Maintenance, and Service Vehicles*, 1997.

SAE J994, *Alarm — Backup — Electric, Laboratory Performance Testing*, 2003.

SAE J1127, *Battery Cable*, 2000.

SAE J1128, *Low Tension Primary Cable*, 2000.

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

SAE J1318, *Gaseous Discharge Warning Lamp for Authorized Emergency, Maintenance, and Service Vehicles*, 1998.

SAE J1330, *Photometry Laboratory Accuracy Guidelines*, 2000.

SAE J1690, *Flashers*, 1996.

SAE J1849, *Emergency Vehicle Sirens*, 2002.

SAE J1888, *High Current Time Lag Electric Fuses*, 1990.

SAE J1889, *L.E.D. Signal and Marking Lighting Devices*, 2005.

SAE J2077, *Miniature Blade Type Electrical Fuses*, 1990.

SAE J2180, *A Tilt Table Procedure for Measuring the Static Roll-over Threshold for Heavy Trucks*, 1998.

2.3.5 TRA Publication. The Tire and Rim Association, Inc., 175 Montrose West Ave., Suite 150, Copley, OH 44321.

Tire and Rim Association — Year Book, 2005.

2.3.6 UL Publication. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 969, *Standard for Marking and Labeling Systems*, 1995.

2.3.7 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Title 49, Code of Federal Regulations, Part 178.37, "Specification 3AA and 3AAX seamless steel cylinders."

Title 49, Code of Federal Regulations, Part 393.94(c), "Vehicle interior noise levels test procedure."

Title 29, Code of Federal Regulations, Part 1910.169, "Air receivers."

Title 49, Code of Federal Regulations, Part 571, "Federal Motor Vehicle Safety Standards (FMVSS)":

No. 209, "Seat belt assemblies"

No. 210, "Seat belt assembly anchorages"

No. 302, "Flammability of interior materials"

2.3.8 Other Publication.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2002 edition.

NFPA 70, *National Electrical Code*®, 2005 edition.

NFPA 1150, *Standard on Foam Chemicals for Fires in Class A Fuels*, 2004 edition.

NFPA 1451, *Standard for a Fire Service Vehicle Operations Training Program*, 2002 edition.

NFPA 1901, *Standard for Automotive Fire Apparatus*, 2003 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Shall. Indicates a mandatory requirement.

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

3.3 General Definitions.

3.3.1 Acceptance. An agreement between the purchasing authority and the contractor that the terms and conditions of the contract have been met. [1901, 2003]

3.3.2 Acceptance Tests. Tests performed on behalf of or by the purchaser at the time of delivery to determine compliance with the specifications for the fire apparatus. [1901, 2003]

3.3.3 Active Horizontal Angles of Light Emission. The angles, measured in a horizontal plane passing through the optical center of the optical source, as specified by the manufacturer of the optical device, between which the optical source contributes optical power. [1901, 2003]

3.3.4 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. [1901, 2003]

3.3.5 Angle of Departure. The smallest angle made between the road surface and a line drawn from the rear point of ground contact of the rear tire to any projection of the apparatus behind the rear axle. [1901, 2003]

3.3.6 ASME Pressure Vessel. A pressure vessel used for the storage or accumulation of air or gas under pressure that is constructed and tested in accordance with the ASME *Boiler and Pressure Vessel Code*. [1901, 2003]

3.3.7 Automatic Electrical Load Management System. A device that continuously monitors the electrical system voltage and automatically sheds predetermined loads in a selected order to prevent overdischarging of the apparatus' batteries. [1901, 2003]

3.3.8* Automatic Regulating Foam Proportioning System. A foam proportioning system that automatically adjusts the flow of foam concentrate into the water stream to maintain the desired proportioning ratio.

3.3.9 Auxiliary Braking System. A braking system in addition to the service brakes, such as an engine retarder, transmission retarder, driveline retarder, or exhaust retarders. [1901, 2003]

3.3.10 Auxiliary Engine-Driven Pumps. Pumps whose power is provided by engines that are independent of the vehicle engine.

3.3.11 Back-Up Alarm. An audible device designed to warn that the fire apparatus is in reverse gear. [1901, 2003]

3.3.12 Battery Disconnect Switch. A switch that disconnects the battery from all of the vehicle's wiring.

3.3.13 Bubble (Foam). A thin-walled, roughly spherical, film of liquid inflated with air. [1901, 2003]

3.3.14 Carbon Monoxide Monitor. A monitoring device that samples a purified air stream for trace elements of carbon monoxide (CO). [1901, 2003]

3.3.15 Center of Gravity. The point at which the entire weight of the fire apparatus is considered to be concentrated so that, if supported at this point, the apparatus would remain in equilibrium in any position. [1901, 2003]

3.3.16 Chassis. The basic operating motor vehicle including the engine, frame, and other essential structural and mechanical parts, but exclusive of the body and all appurtenances for the accommodation of driver, property, passengers, appliances, or equipment related to other than control. Common usage might, but need not, include a cab (or cowl). [1901, 2003]

3.3.17 Class A Fires. Fires in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics. [10, 2002]

3.3.18 Class A Foam. Foam for use on fires in Class A fuels. [1150, 2004]

3.3.19* Compound Gauge. A gauge that indicates pressure both above and below atmospheric pressure. [1901, 2003]

3.3.20* Compressed Air Foam System (CAFS). A foam system that combines air under pressure with foam solution to create foam. [1901, 2003]

3.3.21 Continuous Duty. Operation at a substantially constant load for an indefinitely long time. [70, 2005]

3.3.22* Contractor. The person or company responsible for fulfilling an agreed-upon contract. [1901, 2003]

3.3.23 Convenient Reach. The ability of the operator to manipulate the controls from a driving/riding position without excessive movement away from the seat back or without excessive loss of eye contact with the roadway. [1901, 2003]

3.3.24 Defect. A discontinuity in a part or a failure to function that interferes with the service or reliability for which the part was intended. [1901, 2003]

3.3.25 Discharge Outlet Size. The nominal size of the first fire hose connection from the pump on a discharge. [1901, 2003]

3.3.26 DOT Cylinder. A pressure vessel constructed and tested in accordance with Title 49 CFR 178.37 that is used for the storage and transportation of air under pressure. [1901, 2003]

3.3.27* Eductor. A device placed in a hose line or a discharge pipe that incorporates a venturi and proportions foam concentrate or other fire-fighting agents into the water stream. [1901, 2003]

3.3.28* Ejector. An appliance used to fill a fire engine's tank when the water source is below or beyond the engine's drafting capability.

3.3.29* Electric Siren (Electromechanical). An audible warning device that produces sound by the use of an electric motor with an attached rotating slotted or perforated disc. [1901, 2003]

3.3.30* Electronic Siren. An audible warning device that produces sound electronically through the use of amplifiers and electromagnetic speakers. [1901, 2003]

3.3.31 Emergency Vehicle. A fire apparatus or other vehicle that is permitted by law to call for the right of way while responding to an incident affecting the public safety and to block the public road while at the scene of such an incident.

3.3.32 Enclosed Compartment. An area designed to protect stored items from environmental damage (weather resistant) that is confined on six sides and equipped with an access opening(s) that can be closed and latched. [1901, 2003]

3.3.33 Estimated In-Service Weight. The amount that the fire apparatus manufacturer estimates the apparatus will weigh when it is placed in service with all fixed and portable equipment installed, all tanks full, and all personnel seating positions occupied.

3.3.34 Expansion Ratio. The ratio of the volume of foam in its aerated state to the original volume of nonaerated foam solution. [1901, 2003]

3.3.35 Final-Stage Manufacturer. A person who performs such manufacturing operations on an incomplete vehicle that it becomes a completed vehicle.

3.3.36 FMVSS. Abbreviation for Federal Motor Vehicle Safety Standard. Regulations promulgated by National Highway Transportation Safety Administration (NHTSA) of the United States under Public Law 89-563, which are mandatory and must be complied with when motor vehicles or items of motor vehicle equipment are manufactured and certified thereto. [1901, 2003]

3.3.37 Foam. An aerated fire-extinguishing solution created by mixing air into foam solution to form bubbles. [1901, 2003]

3.3.38 Foam Concentrate. Foam fire-fighting agent as received from the manufacturer that must be diluted with water to make foam solution. [1901, 2003]

3.3.39 Foam Proportioner. A device or method to add foam concentrate to water to make foam solution. [1901, 2003]

3.3.40 Foam Proportioning System. The apparatus and techniques used to mix concentrate with water to make foam solution. [1901, 2003]

3.3.41 Foam Solution. A homogeneous mixture of water and foam concentrate in the proper proportions. [1901, 2003]

3.3.42 Fully Enclosed Personnel Area. A driver or passenger compartment on the fire apparatus that provides total enclosure on all sides, top, and bottom and has positive latching on all access doors. [1901, 2003]

3.3.43 Gallon. United States gallon. [1901, 2003]

3.3.44 Gauge. A visual device that indicates a measurement.

3.3.45 Gauge Pressure. Pressure measured by an instrument where the pressure indicated is relative to atmospheric pressure. [1901, 2003]

3.3.46* GAWR (Gross Axle Weight Rating). The final stage manufacturer's specified maximum load-carrying capacity of an axle system, as measured at the tire-ground interfaces.

3.3.47* Grade. A measurement of the angle used in road design and expressed as a percentage of elevation change over distance. [1901, 2003]

3.3.48 Ground Clearance. The clearance under a vehicle at all locations except the axles and driveshaft connections to the axle or items designed to swing clear.

3.3.49* GVWR (Gross Vehicle Weight Rating). The final-stage manufacturer's specified maximum load-carrying capacity of a vehicle having two axle systems (a multi-axle axle installation is one system).

3.3.50 Intake Connection Size. The nominal size of the first fire hose connection from the pump on an intake. [1901, 2003]

3.3.51 Interlock. A device or arrangement by means of which the functioning of one part is controlled by the functioning of another. [1901, 2003]

3.3.52 Label. A visual indication whether in pictorial or word format that provides for the identification of a control, switch, indicator, or gauge, or the display of information useful to the operator. [1901, 2003]

3.3.53 Low-Voltage Circuit, Equipment, or System. An electrical circuit, equipment, or system where the voltage does not exceed 30 volts (V) rms (ac) or 42.4 V peak (dc), usually 12 V dc in fire apparatus. [1901, 2003]

3.3.54 Manually Regulated Foam Proportioning System. A foam proportioning system that requires manual adjustment to maintain the proportioning ratio when there is a change of flow or pressure through the foam proportioner.

3.3.55 Manufacturer. The person or persons, company, firm, corporation, partnership, or other organization responsible for turning raw materials or components into a finished product. [1901, 2003]

3.3.56* Maximum Pump Close-Off Pressure. The maximum pump discharge pressure obtained with all discharge outlets closed, with the pump primed and running with the pump drive engine operating at maximum obtainable speed, and with the pump intake pressure at atmospheric pressure or less. [1901, 2003]

3.3.57 Minimum Continuous Electrical Load. The electrical current required to continuously operate a defined set of electrical devices. [1901, 2003]

3.3.58 Miscellaneous Equipment. Portable tools and equipment carried on a fire apparatus not including suction hose, fire hose, ground ladders, fixed power sources, hose reels, cord reels, breathing air systems, or other major equipment or components specified by the purchaser to be permanently mounted on the apparatus as received from the apparatus manufacturer. [1901, 2003]

3.3.59 Miscellaneous Equipment Allowance. That portion of the GVWR allocated for the weight of the miscellaneous equipment and its mounting brackets, boards, or trays.

3.3.60 Momentary Switch. A switch that returns to the neutral position (off) when released. [1901, 2003]

3.3.61 National Hose Thread (NH). A standard screw thread that has dimensions for inside (female) and outside (male) fire hose connections as defined in NFPA 1963, *Standard for Fire Hose Connections*. [1901, 2003]

3.3.62* Net Pump Pressure. The sum of the discharge pressure and the suction lift converted to psi or kPa when pumping at draft, or the difference between the discharge pressure and the intake pressure when pumping from a hydrant or other source of water under positive pressure. [1901, 2003]

3.3.63 Nozzle Reaction. Force that occurs when a water stream is discharged from the nozzle. [1901, 2003]

3.3.64 NPSH (National Pipe Straight Hose Thread). National pipe straight hose coupling thread as specified in ASME B1.20.7, *Hose Coupling Screw Threads, Inch*.

3.3.65* Off-Road Use Vehicle. A vehicle designed to be used on other than paved or improved roads, especially in areas where no roads, poor roads, and steep grades exist and where natural hazards, such as rocks, stumps, and logs, protrude from the ground.

3.3.66 Operator's Panel. A panel containing gauges, switches, instruments, or controls where an operator can visually monitor the applicable functions. [1901, 2003]

3.3.67 Optical Center. The point specified by the optical warning device manufacturer of highest intensity when measuring the output of an optical warning device. [1901, 2003]

3.3.68 Optical Power. A unit of measure designated as candelas/seconds/minute that combines the flash energy and flash rate of an optical source into one power measurement representing the true visual effectiveness of the emitted light. [1901, 2003]

3.3.69* Optical Source. Any single, independently mounted, light-emitting component in a lighting system. [1901, 2003]

3.3.70 Optical Warning Device. A manufactured assembly of one or more optical sources. [1901, 2003]

3.3.71 Personal Equipment Weight. A weight allowance for personal gear that is carried on the apparatus by each fire-fighting crew member.

3.3.72 Plate. A visual indication whether in pictorial or word format that provides instruction to the operator in the use of a component on the apparatus. [1901, 2003]

3.3.73* Preconnected Hose Line. A hose line that is stored on the apparatus already connected to an outlet on a pump and that can be charged by the activation of one discharge valve. [1901, 2003]

3.3.74 PTO. Power takeoff. [1901, 2003]

3.3.75 Pump Operator's Panel. The area on a fire apparatus that contains the gauges, controls, and other instruments used for operating the pump. [1901, 2003]

3.3.76 Pump Operator's Position. The location from which the pump operator operates the pump. [1901, 2003]

3.3.77 Purchaser. The authority having responsibility for the specification and acceptance of the apparatus. [1901, 2003]

3.3.78 Purchasing Authority. The agency that has the sole responsibility and authority for negotiating, placing, and, where necessary, modifying each and every solicitation, purchase order, or other award issued by a governing body. [1901, 2003]

3.3.79 Qualified Person. A person who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, has demonstrated the ability to deal with problems relating to a particular subject matter, work, or project. [1451, 2002]

3.3.80 Ramp Breakover Angle. The angle measured between two lines tangent to the front and rear tire static loaded radius, and intersecting at a point on the underside of the vehicle that defines the largest ramp over which the vehicle can roll.

3.3.81 Rated Capacity (Water Pump). The flow rate to which the pump manufacturer certifies compliance of the pump when it is new. [1901, 2003]

3.3.82 Readily Accessible. Able to be located, reached, serviced, or removed without removing other components or parts of the apparatus and without the need to use special tools to open enclosures. [1901, 2003]

3.3.83 Reserve Capacity. The ability of a battery to sustain a minimum electrical load in the event of a charging system failure or a prolonged charging system deficit. [1901, 2003]

3.3.84 Sign. A visual indication whether in pictorial or word format that provides a warning to the operator or other persons near the apparatus. [1901, 2003]

3.3.85* Slip-On Fire-Fighting Module. A self-contained unit that includes an auxiliary engine-driven pump, piping, a tank, and hose storage that is designed to be placed on a truck chassis, utility bed, flatbed, or trailer of sufficient carrying capacity.

3.3.86 Slow-Operating Valve. A valve that has a mechanism to prevent movement of the flow-regulating element from the fully closed position to the fully opened position or vice versa in less than 3 seconds. [1901, 2003]

3.3.87 Split Shaft PTO. A power takeoff (PTO) drive system that is inserted between the chassis transmission and the chassis drive axle and that has the shift mechanism necessary to direct the chassis engine power either to the drive axle or to a fire pump or other accessory. [1901, 2003]

3.3.88 Standard Cubic Feet per Minute (SCFM). An expression of airflow rate in which the airflow rate is corrected to standard temperature and pressure. Standard temperature is 60°F (15°C) and standard pressure is 14.696 psi (101.33 kPa) or 29.92 in. Hg (760 mm Hg).

3.3.89 Suction Lift. The sum of the vertical lift and the friction and entrance loss caused by the flow through the intake strainers and hose expressed in feet of water (meters of water) head. [1901, 2003]

3.3.90 Sump. A recessed area of a tank assembly designed primarily to entrap sludge or debris for removal and to serve as a central liquid collection point. [1901, 2003]

3.3.91 Swash Partition. A vertical wall within a tank structure designed to control the unwanted movement of the fluid within that tank. [1901, 2003]

3.3.92 Turning Clearance Radius. One-half the larger of the left or right full circle wall-to-wall turning diameter. [1901, 2003]

3.3.93 Wildland Fire Apparatus. Fire apparatus designed for fighting wildland fires that is equipped with a pump having a capacity normally between 10 gpm and 500 gpm (38 L/min and 1900 L/min), a water tank, limited hose and equipment, and that has pump-and-roll capability.

Chapter 4 General Requirements

4.1 General.

4.1.1 All wildland fire apparatus shall meet the requirements of the following chapters:

- (1) Chapter 1, "Administration"
- (2) Chapter 2, "Referenced Publications"
- (3) Chapter 3, "Definitions"
- (4) Chapter 4, "General Requirements"
- (5) Chapter 5, "Chassis and Vehicle Components"
- (6) Chapter 6, "Low-Voltage Electrical Systems and Warning Devices"
- (7) Chapter 7, "Driving and Crew Areas"
- (8) Chapter 8, "Body, Compartments, and Equipment Mounting"
- (9) Chapter 9, "Water Pumps"
- (10) Chapter 11, "Water Tanks"
- (11) Chapter 12, "Equipment Carried on Wildland Fire Apparatus"

4.1.2 If the water pump is driven by a separate engine, the water pump engine shall meet the requirements of Chapter 10.

4.1.3 If the apparatus is equipped with a foam proportioning system, the system shall meet the requirements of Chapter 13.

4.1.4 If the apparatus is equipped with a compressed air foam system (CAFS), the system shall meet the requirements of Chapter 14.

4.1.5 If the apparatus is equipped with a chassis mounted winch, the winch shall meet the requirements of Chapter 15.

4.1.6 If the apparatus is equipped with a vehicle protection system, the system shall meet the requirements of Chapter 16.

4.2 Responsibility of the Purchaser.

4.2.1* It shall be the responsibility of the purchaser to specify the following details of the apparatus:

- (1) Its required performance, including operations at elevations above 2000 ft (600 m), or across grades greater than 20 percent, or up and down grades greater than 25 percent, or stationary operations on grades greater than 10 percent
- (2) The maximum number of fire fighters to ride within the apparatus
- (3) Specific electrical loads that are to be part of the minimum continuous electrical load defined in 6.3.3
- (4) Any hose, ground ladders, or equipment to be carried by the apparatus that exceed the minimum requirements of this standard
- (5) If the vehicle is to be equipped to call for or block right-of-way on public highways
- (6) Any special arrangements or locations for tools and equipment to be carried on the fire apparatus

4.2.2* After acceptance of the fire apparatus, the purchaser shall be responsible for ongoing training of its personnel to develop and maintain proficiency regarding the proper and safe use of the apparatus and its associated equipment.

4.3 Responsibility of the Contractor.

4.3.1 The contractor shall provide 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.

4.3.1.1 The detailed description of the apparatus shall include, but shall not be limited to, estimated in-service weight, wheelbase, turning clearance radius, principal dimensions, angle of approach, angle of departure, ramp breakover angle, transmission, and axle ratios, if applicable.

4.3.1.2 The purpose of these contractor specifications shall be to define what the contractor intends to furnish and deliver to the purchaser.

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

4.4 Legal Requirements. The apparatus shall comply with all applicable federal and state or provincial laws and regulations.

4.5 Manufacturer Certification of Test Results. Where this standard requires the results of tests or the performance of a component to be certified by the manufacturer, the manufacturer shall meet the requirements of this section.

4.5.1 A representative of the manufacturer shall witness all tests and shall refuse to certify any test results for a system unless all components of that system requiring testing pass the testing required by this standard.

4.5.2 There shall be no conditional, temporary, or partial certification of test results.

4.5.3 The manufacturer shall have the facilities and equipment necessary to conduct the required testing, a program for the calibration of all instruments, and procedures to ensure the proper control of all testing.

4.5.4 Appropriate forms or data sheets shall be provided and used during the testing.

4.5.5 Programs shall be in place for training, proficiency testing, and performance verification of any personnel involved with certification.

4.5.6 An official of the company that manufactures or installs the product or component shall designate in writing who is qualified to witness tests and certify results.

4.6 Personnel Protection.

4.6.1* Guards, shields, or other protection shall be provided where necessary in order to prevent injury of personnel by hot, moving, or rotating parts during nonmaintenance operations.

4.6.2 Electrical insulation or isolation shall be provided where necessary in order to prevent electrical shock from on-board electrical systems.

4.6.3 Vehicular workmanship shall ensure an operating environment free of accessible sharp projections and edges.

4.6.4 Safety-related (caution, warning, danger) signs shall meet the requirements of NEMA Z535.4, *Standard for Product Safety Signs and Labels*.

4.7 Controls and Instructions.

4.7.1 Illumination shall be provided for controls, switches, instruction plates, gauges, and instruments necessary for the operation of the apparatus and the equipment provided on it.

4.7.1.1 If external illumination is provided, it shall be a minimum of 5 fc (50 lx) on the face of the device.

4.7.1.2 If internal illumination is provided, it shall be a minimum of 4 footlamberts (14 candela/m²).

4.7.2* All required signs, plates, and labels shall be permanent in nature and securely attached and shall meet the requirements of 4.6.4 and UL 969, *Standard for Marking and Labeling Systems*.

4.7.2.1 The signs, plates, and labels shall have resistance to damage from temperatures between –30°F and 176°F (–35°C and 80°C) and exposure to oil, fuel, water, hydraulic fluids, or other fluids used on the apparatus.

4.7.2.2 The exterior mounted labels relating to safety or critical operational instructions shall be reflective or illuminated as required by 4.7.1.

4.7.3 No gauge or visual display shall be more than 84 in. (2.1 m) above the level where the operator stands to read the instrument.

4.7.4 The central midpoint or centerline of any control shall be no more than 72 in. (1.8 m) vertically above the ground or platform that is designed to serve as the operator's standing position.

4.8 Component Protection.

4.8.1* Hydraulic hose lines, air system tubing, control cords, and electrical harness lines shall be mechanically attached to the frame or body structure of the apparatus.

4.8.2 The type of equipment described in 4.8.1 shall be furnished with protective looms, grommets, or other devices at each point where they pass through body panels or structural members or wherever they lie against a sharp metal edge.

4.8.3 A through-the-frame connector shall be permitted to be used in place of metal protective looms or grommets.

4.9 Vehicle Stability.

4.9.1* When the apparatus is loaded to its GVWR, with test weight distributed as close as practical to the intended in-service configuration, it shall meet one of the following two criteria:

- (1) The calculated center of gravity shall be no higher than 75 percent of the rear vehicle axle track width for a vehicle with a GVWR of 33,000 lb (14,969 kg) or less, and 85 percent of the rear vehicle axle track width for a vehicle with a GVWR greater than 33,000 lb (14,969 kg). The rear vehicle axle track width shall be measured from the center of the rear wheel assembly on one side of the vehicle to the center of the rear wheel assembly on the other side.
- (2) When the fire apparatus is tested once in each direction in accordance with SAE J2180, *A Tilt Table Procedure for Measuring the Static Rollover Threshold for Heavy Trucks*, the fire apparatus shall be able to be tilted to 30° before lifting a front or rear tire if the vehicle has a GVWR of 33,000 lb (14,969 kg) or less, and tilted to 27 degrees before lifting a front or rear tire if the GVWR is greater than 33,000 lb (14,969 kg).

4.9.2 Weight Distribution.

4.9.2.1* When the apparatus is loaded to its estimated in-service weight, the front-to-rear weight distribution shall be within the limits set by the chassis manufacturer.

4.9.2.2 The front axle loads shall not be less than the minimum axle loads specified by the chassis manufacturer, under full load and all other loading conditions.

4.9.3 Load Distribution.

4.9.3.1* Using the information supplied by the purchaser, the apparatus manufacturer shall calculate the load distribution for the apparatus.

4.9.3.2 The manufacturer shall engineer the fire apparatus to comply with the gross axle weight rating (GAWR), the overall gross vehicle weight rating (GVWR), and the chassis manufacturer's load balance guidelines.

4.9.3.3* The fire apparatus, when loaded to its estimated in-service weight, shall have a side-to-side tire load variation of no more than 7 percent of the total tire load for that axle.

4.10 Fire Apparatus Performance.

4.10.1* The fire apparatus shall meet the requirements of this standard at elevations of 2000 ft (600 m) above sea level.

4.10.2* The fire apparatus shall meet all the requirements of this standard while stationary on a grade of 10 percent in any direction.

4.10.3* The fire apparatus shall meet the requirements of this standard in ambient temperature conditions between 32°F (0°C) and 110°F (43°C).

4.11 Roadability.

4.11.1 The fire apparatus, when loaded to its estimated in-service weight, shall be capable of the following performance while on dry, paved roads that are in good condition:

- (1) From a standing start, the apparatus shall attain a speed of 35 mph (55 km/hr) within 25 seconds on a level road.
- (2)*If the apparatus is designed to respond on public roads, it shall attain a minimum top speed of 50 mph (80 km/hr) on a level road.
- (3)*The apparatus shall be able to maintain a speed of at least 20 mph (32 km/hr) on any grade up to and including 6 percent.

4.11.2* The vehicle shall be capable of maneuvering across a 20 percent grade and up and down a 25 percent grade.

4.11.3* The maximum top speed of the apparatus shall not exceed the tire manufacturer's continuous maximum speed rating for the tires installed on the apparatus.

4.12 Serviceability.

4.12.1 The fire apparatus shall be designed so that all the manufacturer's recommended routine maintenance checks of lubricant and fluid levels can be performed by the operator without lifting the cab of a tilt-cab apparatus or without the need for hand tools.

4.12.2 Where special tools are required for routine service on any component of the apparatus, such tools shall be provided with the apparatus.

4.12.3 Apparatus components that interfere with repair or removal of other major components shall be attached with fasteners, such as cap screws and nuts, so that the components can be removed and installed with ordinary hand tools. These components shall not be welded or otherwise permanently secured into place.

4.12.4 At least two copies of a complete, detailed operation and service manual for the apparatus shall be provided. This manual shall include the chassis, pump, wiring diagrams, lubrication charts, and fire-fighting equipment for that apparatus.

4.13 Road Tests.

4.13.1 Road tests shall be conducted in accordance with this section to verify that the completed fire apparatus is capable of compliance with Section 4.11.

4.13.2 The tests shall be conducted at a location and in a manner that does not violate local, state or provincial, or federal traffic laws.

4.13.3 The tests shall be conducted on dry, level, paved roads that are in good condition.

4.13.4 The apparatus shall be loaded to its estimated in-service weight.

4.13.5 The engine shall not operate in excess of the maximum governed speed.

4.13.6 Acceleration tests shall consist of two runs in opposite directions over the same route.

4.13.6.1 The fire apparatus shall attain a speed of 35 mph (55 km/hr) from a standing start within 25 seconds.

4.13.6.2 If the fire apparatus is designed to respond on public roads as an emergency vehicle, it shall attain a minimum top speed of 50 mph (80 km/hr).

4.13.7 If the apparatus is equipped with an auxiliary braking system, the manufacturer shall road test the system to confirm that the system is functioning as intended by the auxiliary braking system manufacturer.

4.13.8 If the apparatus is equipped with an air brake system, the service brakes shall bring the apparatus, when loaded to its GVWR, to a complete stop from an initial speed of 20 mph (32.2 km/hr), in a distance not exceeding 35 ft (10.7 m) by actual measurement on a paved, level, dry surface road that is free of loose material, oil, or grease.

4.13.9 If the apparatus is equipped with a hydraulic brake system, the service brakes shall bring the apparatus, when loaded to its GVWR, to a complete stop from an initial speed of 30 mph (48.2 km/hr), in a distance not exceeding 88 ft (26.8 m) by actual measurement on a paved, level, dry surface road that is free of loose material, oil, or grease.

4.14* Tests on Delivery. If acceptance tests are required at the point of delivery, the purchaser shall specify the details of the tests to be performed and they shall not be performed in a manner that requires the apparatus or a component to operate outside its designed operating range.

4.15* Apparatus Certification. The manufacturer or organization responsible for the final assembly of the fire apparatus shall certify that the following criteria have been met:

- (1) The weight of the completed apparatus, when loaded to its estimated in-service weight, does not exceed the GVWR and GAWR of the chassis.
- (2) The complete unit, when loaded to its estimated in-service weight, meets the weight distribution and vehicle stability requirements, as defined in Section 4.9.
- (3)*The unit meets all required federal standards pertaining to the manufacture and completion of the fire apparatus, and a label or tag has been affixed to the apparatus by the manufacturer stating the same.

4.16* Documentation. Any documentation provided with the apparatus shall be permitted to be in printed format, electronic format, audiovisual format, or a combination thereof.

4.17 Data Required of the Contractor.

4.17.1 Fire Apparatus Documentation. The contractor shall supply, at the time of delivery, at least one copy of the following documents:

- (1) The manufacturer's record of apparatus construction details, including the following information:
 - (a) Owner's name and address
 - (b) Apparatus manufacturer, model, and serial number
 - (c) Chassis make, model, and serial number
 - (d) GAWR of front and rear axles and GVWR
 - (e) Front tire size and total rated capacity in pounds (kilograms)
 - (f) Rear tire size and total rated capacity in pounds (kilograms)
 - (g) Chassis weight distribution in pounds (kilograms) with water and manufacturer mounted equipment (front and rear)
 - (h) Engine make, model, serial number, rated horsepower and related speed, and governed speed
 - (i) Type of fuel and fuel tank capacity
 - (j) Electrical system voltage and alternator output in amps
 - (k) Battery make, model, and capacity in cold cranking amps (CCA)
 - (l) Chassis transmission make, model, and serial number; and if so equipped, chassis transmission PTO(s) make, model, and gear ratio
 - (m) Ratios of all driving axles
 - (n) Maximum governed road speed
 - (o) Pump make, model, rated capacity in gallons per minute (liters per minute where applicable) and serial number
 - (p) Pump transmission make, model, serial number, and gear ratio
 - (q) Auxiliary pump make, model, rated capacity in gallons per minute (liters per minute where applicable) and serial number
 - (r) Water tank certified capacity in gallons or liters
 - (s) Paint manufacturer and paint number(s)
 - (t) Company name and signature of responsible company representative
- (2) The pump manufacturer's certification of suction capability (*see Section 9.2*)
- (3) The pump manufacturer's certification of hydrostatic test (*see 9.4.2*)
- (4) The certification of inspection and test by the pump manufacturer or contractor (*see 9.11.1.2*)
- (5) Weight documents from a certified scale showing actual loading on the front axle, rear axle(s), and overall fire apparatus (with the water tank full but without personnel, equipment, and hose)
- (6) Written load analysis and results of the electrical system performance tests required in Section 6.14
- (7) Certification of slip resistance of all stepping, standing, and walking surfaces (*see 8.6.3.5*)
- (8) Certification of vehicle side slope stability including the weight distribution assumed for the calculations or as loaded on the vehicle for the tilt table test (*see 4.9.1*)

4.17.2 Operations and Service Documentation.

4.17.2.1 The contractor shall supply, at time of delivery, at least two sets of complete operation and service documentation covering the completed apparatus as delivered and accepted.

4.17.2.2 The documentation shall address at least the inspection, service, and operations of the fire apparatus and all major components thereof.

4.17.2.3 The contractor shall also provide the following documentation for the entire apparatus and each major operating system or major component of the apparatus:

- (1) Manufacturer's name and address
- (2) Country of manufacture
- (3) Source for service and technical information
- (4) Parts replacement information
- (5) Descriptions, specifications, and ratings of the chassis and pump
- (6) Wiring diagrams for low-voltage and line-voltage systems to include the following information:
 - (a) Pictorial representations of circuit logic for all electrical components and wiring
 - (b) Circuit identification
 - (c) Connector pin identification
 - (d) Zone location of electrical components
 - (e) Safety interlocks
 - (f) Alternator-battery power distribution circuits
 - (g)*Input/output assignment sheets or equivalent circuit logic implemented in multiplexing systems
- (7) Lubrication charts
- (8) Operating instructions for the chassis and any major components such as the pump, and any auxiliary systems
- (9) Instructions regarding the frequency and procedure for recommended maintenance
- (10) Overall apparatus operating instructions
- (11) Safety considerations
- (12) Limitations of use
- (13) Inspection procedures
- (14) Recommended service procedures
- (15) Troubleshooting guide
- (16) Apparatus body, chassis, and other component manufacturer's warranties
- (17) Special data required by this standard
- (18) Copies of required manufacturer test data or reports, manufacturer certifications, and independent third-party certifications of test results
- (19) A material safety data sheet (MSDS) for any fluid that is specified for use on the apparatus

4.17.2.4* The contractor shall deliver with the apparatus all manufacturers' operations and service documents supplied with components and equipment that are installed or supplied by the contractor.

Chapter 5 Chassis and Vehicle Components

5.1* Carrying Capacity. The GAWR and GVWR of the chassis shall be adequate to carry the weight of the fire apparatus when loaded to its estimated in-service weight as defined in 5.1.2.

5.1.1 The manufacturer shall establish the estimated in-service weight during the design of the fire apparatus.

5.1.2 The estimated in-service weight shall include the following:

- (1) The chassis, body, and tank(s)
- (2) Full fuel, lubricant, and other chassis or component fluid tanks or reservoirs
- (3) Full water and other agent tanks

- (4)*200 lb (90 kg) in each seating position
- (5) 70 lb (32 kg) for each seating position for personal gear unless the purchaser specifies that personal gear is not carried on the apparatus
- (6) Fixed equipment such as pumps, aerial devices, generators, reels, and air systems as installed
- (7) Ground ladders, suction hose, designed hose load in their hose beds and on their reels
- (8) An allowance for miscellaneous equipment that is the greatest of the values shown in Table 5.1.2, a purchaser-provided list of equipment to be carried with weights, or a purchaser-specified miscellaneous equipment allowance

Table 5.1.2 Minimum Miscellaneous Equipment Allowance

Chassis GVWR		Equipment Weight	
lb	kg	lb	kg
5,000–10,000	2,200–4,500	300	135
10,001–15,000	4,501–7,000	500	225
15,001–20,000	7,001–9,000	1,000	455
20,001–26,000	9,001–12,000	1,500	680
>26,000	>12,000	2,000	910

5.1.3 The manufacturer shall engineer and design the fire apparatus such that the completed apparatus, when loaded to its estimated in-service weight, with all movable weights distributed as close as is practical to their intended in-service configuration, does not exceed the gross vehicle weight rating (GVWR).

5.1.4* A final-stage manufacturer's certification of the GVWR, along with a certification of the GAWR, shall be supplied on a label affixed to the vehicle.

5.1.5 The fire apparatus manufacturer shall permanently affix a high-visibility plate in a location visible to the driver while seated.

5.1.5.1* The plate shall show the height of the completed fire apparatus in feet and inches or meters, the length of the completed fire apparatus in feet and inches or meters, and the gross vehicle weight rating (GVWR) in pounds or kilograms.

5.1.5.2 Wording on the plate shall indicate that the information shown was current when the apparatus was manufactured and that, if the overall height changes while the vehicle is in service, the fire department must revise that dimension on the plate.

5.2 Engine and Engine System Design.

5.2.1 Chassis Engine.

5.2.1.1* An engine governor or electronic fuel control system shall be installed that will limit the speed of the engine under all conditions of operation to that speed established by the engine manufacturer, which shall be the maximum governed speed.

5.2.1.2* Automatic engine shutdown systems shall not be permitted unless they are an integral part of the standard engine management system that cannot be disabled.

5.2.1.3 The installation of the engine, transmission, and engine- and transmission-driven accessories (PTOs, etc.) shall meet the engine and transmission manufacturers' installation recommendations for the service intended.

5.2.1.4 Engine Speed Control Device.

5.2.1.4.1* An engine speed control device shall be installed to allow an increase in the engine speed when the apparatus is parked.

5.2.1.4.2* An interlock shall prevent the operation of this engine speed control device unless the parking brake is fully engaged and the transmission is in neutral or park, or unless the engine speed control device is used with chassis engine-driven components, in which case it shall be interlocked with the engagement of those components.

5.2.2 Cooling System.

5.2.2.1* The engine's cooling system shall maintain a temperature in the engine at or below the engine manufacturer's maximum temperature rating under all conditions for which the apparatus is designed.

5.2.2.2 Drain Valves.

5.2.2.2.1 Readily accessible drain valves shall be installed at the lowest point of the cooling system and at such other points as are necessary to permit complete removal of the coolant from the system.

5.2.2.2.2 Drain valves shall be designed such that they will not open accidentally due to vibration or be opened by encountering brush or other objects.

5.2.2.3 The radiator shall be mounted to prevent the development of leaks caused by twisting or straining where the apparatus operates over uneven ground.

5.2.2.4 Radiator cores shall be compatible with commercial antifreeze solutions.

5.2.3 Lubrication System.

5.2.3.1* The engine shall be provided with an oil filter of the type approved by the engine manufacturer.

5.2.3.2 The engine oil fill-pipe shall be large enough and located so as to allow easy filling.

5.2.3.3 A permanent plate in the driving compartment shall specify the quantity and type of the following fluids used in the vehicle:

- (1) Engine oil
- (2) Engine coolant
- (3) Chassis transmission fluid
- (4) Pump transmission lubrication fluid
- (5) Pump priming device fluid
- (6) Drive axle(s) lubrication fluid
- (7) Air-conditioning refrigerant
- (8) Air-conditioning lubrication oil
- (9) Power steering fluid
- (10) Cab tilt mechanism fluid
- (11) Transfer case fluid
- (12) Equipment rack fluid
- (13) CAFS air compressor system lubricant
- (14) Front tire cold pressure
- (15) Rear tire cold pressure

5.2.4 Fuel and Air Systems.

5.2.4.1 Diesel Engines.

5.2.4.1.1 Air Intake System.

5.2.4.1.1.1* An air filter shall be provided in the engine's air intake system.

5.2.4.1.1.2 Air inlet restriction shall not exceed the engine manufacturer's recommendations.

5.2.4.1.1.3* The air inlet shall be equipped with a means of separating water and burning embers from the air intake system such that burning particulate matter larger than 0.039 in. (1.0 mm) in diameter cannot reach the air filter element.

5.2.4.1.1.4 An air restriction indicator shall be mounted in the driving compartment and visible to the driver.

5.2.4.1.2* The fuel supply lines and fuel filters shall meet the engine manufacturer's recommendations.

5.2.4.1.3 Electric Fuel Priming System.

5.2.4.1.3.1* Where an electric fuel priming system is furnished, the valving and piping shall be arranged and marked with a label so that it can be operated only to reprime the fuel system.

5.2.4.1.3.2 When the system is not being intentionally operated, it shall be isolated from the fuel system and inoperable.

5.2.4.1.3.3 The priming system shall be marked with a label to indicate proper operation.

5.2.4.2 Gasoline Engines.

5.2.4.2.1 Air Intake System.

5.2.4.2.1.1* An air filter shall be provided in the engine's air intake system.

5.2.4.2.1.2 Air inlet restriction shall not exceed the engine manufacturer's recommendations.

5.2.4.2.1.3* The air inlet shall be equipped with a means of separating water and burning embers from the air intake system such that burning particulate matter larger than 0.039 in. (1.0 mm) in diameter cannot reach the air filter element.

5.2.4.2.1.4 An air restriction indicator shall be mounted in the driving compartment and visible to the driver.

5.2.4.2.2 Fuel System.

5.2.4.2.2.1 Fuel lines and filters or strainers that meet the engine manufacturer's recommendations shall be provided.

5.2.4.2.2.2 The fuel line(s) shall be located or protected so as not to be subjected to excessive heating from any portion of an exhaust system.

5.2.4.2.2.3 The line(s) shall be protected from mechanical damage.

5.2.5* Exhaust System.

5.2.5.1 The exhaust piping and discharge outlet shall be located or shielded so as not to expose any portion of the apparatus or equipment to excessive heating.

5.2.5.2 Exhaust pipe discharge shall be directed away from the pump operator's position.

5.2.5.3 Silencing devices shall be provided.

5.2.5.4 Exhaust back pressure shall not exceed the limits specified by the engine manufacturer.

5.2.5.5 Where parts of the exhaust system are exposed so that they are likely to cause injury to operating personnel, protective guards shall be provided.

5.3 Vehicle Components.

5.3.1 Braking System.

5.3.1.1 The vehicle shall be equipped with an all-wheel anti-lock braking system if such a system is available from the chassis manufacturer.

5.3.1.2 All brakes shall be readily accessible for adjustment.

5.3.1.3 The service brakes and parking brakes shall be applied by independent means.

5.3.1.4 The service brake application valve, when applied, shall operate all the service brakes on the vehicle.

5.3.1.5* Where air-actuated braking systems are provided, they shall include the following:

- (1) An automatic moisture ejector
- (2) An air drier
- (3) A pressure protection valve to prevent air-operated accessories from drawing air from the air brake system when the air system's pressure drops below 80 psi (552 kPa)

5.3.1.6* Parking Brakes.

5.3.1.6.1 Parking brakes shall control the rear wheels, or all wheels, and shall be of the positive, mechanically actuated type.

5.3.1.6.2 When the fire apparatus is loaded to its GVWR, the parking brake system shall hold the apparatus on at least a 20 percent grade.

5.3.1.6.3 A lockup device to retain applied pressure on hydraulically actuated service brake systems or the use of the "park" position on an automatic transmission shall not be substituted for a separate parking brake system.

5.3.1.7* All apparatus with a GVWR of 36,000 lb (16,330 kg) or greater shall be equipped with an auxiliary braking system.

5.3.1.8* Any time a secondary braking device such as transmission retarders and exhaust restriction devices are used, they shall have a switch to turn them off during adverse road conditions.

5.3.2 Suspension and Wheels.

5.3.2.1* Each load-bearing tire and rim of the fire apparatus shall not carry a weight in excess of the recommended load for the operation of truck tires of the size used, as published in the *Tire and Rim Association — Year Book*, or as recommended by the tire manufacturer, when the apparatus is loaded to its GVWR.

5.3.2.2* The minimum ground clearance shall be as specified in Table 5.3.2.2.

5.3.2.3* An angle of approach and an angle of departure of at least 20 degrees shall be maintained at the front and the rear of the vehicle when it is loaded to its GVWR.

Table 5.3.2.2 Under-Vehicle Clearance

Chassis GVWR		Ground Clearance	
lb	kg	in.	mm
5,000–10,000	2,200–4,500	9	230
10,001–15,000	4,501–7,000	12	300
15,001–20,000	7,001–9,000	13	330
>20,000	>9,000	15	380

5.3.2.4 Clearance for tire chains shall be provided in accordance with SAE J683, *Tire Chain Clearance — Trucks, Buses (except Suburban, Intercity, and Transit Buses), and Combinations of Vehicles*.

5.3.2.5 Steering.

5.3.2.5.1 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 at least 28 degrees for driving front axles.

5.3.2.5.2 Power steering or power-assisted steering shall be provided.

5.3.3 Power Train.

5.3.3.1* Transmission.

5.3.3.1.1 The transmission shall be rated for heavy duty service and shall be designed to match engine torque and speed to the load demand.

5.3.3.1.2 The transmission shall provide the driver with the selection of individual gears or ranges of gears necessary to meet the performance requirements of this standard.

5.3.3.2 If the pump is driven by the chassis engine, the power train shall meet 5.3.3.2.1 and 5.3.3.2.2.

5.3.3.2.1* All components in the power train, from the engine to the pump, and from the engine to the driving axles, shall be capable of transmitting available torque necessary to power the pump, as installed in the apparatus, for the pump performance rating, without exceeding the component manufacturer's continuous duty torque/speed rating.

5.3.3.2.2 When pumping continuously at its rated pump capacity and pressure as specified in Section 9.1, lubricant temperatures in any power train component installed in the apparatus from the engine to the pump shall not exceed the component manufacturer's recommendation for maximum temperature.

5.3.3.3* The power train shall allow the vehicle to function and operate smoothly at 2 mph (3.2 km/hr).

5.3.4 Fuel Tanks.

5.3.4.1* A minimum of a single original equipment manufacturer fuel tank shall be permitted.

5.3.4.2 The tank fill opening shall be marked with a label indicating the type of fuel to be used.

5.3.4.3 The tank fill piping shall be placed so it is protected from mechanical damage during the normal use of the fire apparatus.

5.3.4.4 The tank and the fill piping shall be located or shielded so that they are not exposed to heat from an exhaust system or other source of ignition on the fire apparatus.

5.3.4.5 Gasoline-fueled chassis shall have fuel withdrawal fittings above the normal fuel level.

5.3.5 Towing Attachment Points.

5.3.5.1 Tow hook(s) or tow eye(s) shall be provided at the front and rear of the apparatus to allow recovery if the apparatus becomes stuck.

5.3.5.2 The tow hook(s) or tow eye(s) shall be attached directly to the frame structure and be arranged so there is clear and unobstructed access to the attachment point.

Chapter 6 Low-Voltage Electrical Systems and Warning Devices

6.1* General. Any low-voltage electrical systems or warning devices installed on the fire apparatus shall be appropriate for the mounting location and intended electrical load and shall meet the specific requirements of this chapter.

6.2 Wiring. All electrical circuit feeder wiring supplied and installed by the fire apparatus manufacturer shall meet the requirements of 6.2.1 through 6.2.8.

6.2.1* The circuit feeder wire shall be stranded copper or copper alloy conductors of a gauge rated to carry 125 percent of the maximum current for which the circuit is protected.

6.2.1.1 Voltage drops in all wiring from the power source to the using device shall not exceed 10 percent.

6.2.1.2 The use of star washers for circuit ground connections shall not be permitted.

6.2.1.3 All circuits shall otherwise be wired in conformance with SAE J1292, *Automobile, Truck, Truck-Tractor, Trailer, and Motor Coach Wiring*.

6.2.2 Wiring and Wire Harness Construction.

6.2.2.1 All insulated wire and cable shall conform to SAE J1127, *Battery Cable*; or SAE J1128, *Low Tension Primary Cable*, type SXL, GXL, or TXL.

6.2.2.1.1 All conductors shall be constructed in accordance with SAE J1127 or SAE J1128, except where good engineering practice dictates special strand construction.

6.2.2.1.2 Conductor materials and stranding, other than copper, shall be permitted if all applicable requirements for physical, electrical, and environmental conditions are met as dictated by the end application.

6.2.2.1.3 Physical and dimensional values of conductor insulation shall be in conformance with the requirements of SAE J1127 or SAE J1128, except where good engineering practice dictates special conductor insulation.

6.2.2.2 The overall covering of conductors shall be moisture-resistant loom or braid that has a minimum continuous rating of 194°F (90°C) except where good engineering practice dictates special consideration for loom installations exposed to higher temperatures.

6.2.3 The overall covering of jacketed cables shall be moisture resistant and have a minimum continuous temperature rating of 194°F (90°C) except where good engineering practice dictates special consideration for cable installations exposed to higher temperatures.

6.2.4 All wiring connections and terminations shall use a method that provides a positive mechanical and electrical connection.

6.2.4.1 The wiring connections and terminations shall be installed in accordance with the device manufacturer's instructions.

6.2.4.2 All terminal strips shall have protective covers or enclosures.

6.2.4.3 Wire nut, insulation displacement, and insulation piercing connections shall not be used.

6.2.5 Wiring shall be restrained to prevent damage caused by chafing or ice buildup, and protected against heat, liquid contaminants, or other environmental factors.

6.2.6* Wiring shall be uniquely identified at least every 2 ft (0.6 m) by color coding or permanent marking with a circuit function code. The identification shall reference a wiring diagram. [See 4.17.2.3(6).]

6.2.7 Circuits shall be provided with properly rated low-voltage overcurrent protective devices.

6.2.7.1 Such devices shall be readily accessible and protected against heat in excess of the overcurrent device's design range, mechanical damage, and water spray.

6.2.7.2 Circuit protection shall be accomplished by utilizing fuses, circuit breakers, fusible links, or solid state equivalent devices.

6.2.7.3 If a mechanical-type device is used, it shall conform to one of the following SAE standards:

- (1) SAE J156, *Fusible Links*
- (2) SAE J553, *Circuit Breakers*
- (3) SAE J554, *Electric Fuses (Cartridge Type)*
- (4) SAE J1888, *High Current Time Lag Electric Fuses*
- (5) SAE J2077, *Miniature Blade Type Electrical Fuses*

6.2.8 Switches, relays, terminals, and connectors shall have a direct current (dc) rating of 125 percent of maximum current for which the circuit is protected.

6.3 Power Supply.

6.3.1 A 12 V or 24 V electrical alternator shall be provided.

6.3.2* The alternator shall have a minimum output at idle to meet the minimum continuous electrical load of the fire apparatus as defined in 6.3.3, at 200°F (93°C) ambient temperature within the engine compartment, and shall be provided with full automatic regulation.

6.3.3 The minimum continuous electrical load shall consist of the total amperage required to simultaneously operate the following in a stationary mode during emergency operations:

- (1) The propulsion engine and transmission
- (2) All legally required clearance and marker lights, headlights, and other electrical devices except windshield wipers and four-way hazard flashers
- (3) The radio(s) at a duty cycle of 10 percent transmit and 90 percent receive (for calculation and testing purposes, a default value of 5 A continuous)
- (4) The lighting necessary to produce 5 fc (50 lx) of illumination on all control and instrument panels
- (5) The minimum optical warning system required in Section 6.8, where the apparatus is designed to call for or block the right-of-way
- (6) The continuous electrical current required to simultaneously operate any water pumps and hydraulic pumps
- (7)*Other warning devices and electrical loads defined by the purchaser as critical to the mission of the apparatus

6.3.4* The condition of the low-voltage electrical system shall be monitored by a warning system that provides an audible and visual signal to persons on, in, or near the apparatus of an impending electrical system failure caused by the excessive discharge of the battery set.

6.3.4.1 The charge status of the battery shall be determined either by direct measurement of the battery charge or indirectly by monitoring the electrical system voltage.

6.3.4.2 If electrical system voltage is monitored, the alarm shall sound if the system voltage at the battery drops below 11.8 V for 12 V nominal systems or 23.6 V for 24 V nominal systems for more than 120 seconds.

6.3.5 A voltmeter shall be mounted on the driver's instrument panel to allow direct observation of the system voltage.

6.3.6 Load Management.

6.3.6.1* If the total continuous electrical load exceeds the minimum continuous electrical output rating of the installed alternator(s) operating under the conditions specified in 6.3.2, an automatic electrical load management system shall be required.

6.3.6.2 The minimum continuous electrical loads defined in 6.3.3 shall not be subject to automatic load management.

6.4* Batteries.

6.4.1 Batteries shall be of the high-cycle type.

6.4.2 With the engine off, the battery system shall be able to provide the minimum continuous electrical load for 10 minutes without discharging more than 50 percent of the reserve capacity, and then restart the engine.

6.4.3 The battery system cold cranking amps (CCA) rating shall meet or exceed the minimum CCA recommendations of the engine manufacturer.

6.4.4 The batteries shall be mounted to prevent movement during fire apparatus operation and shall be protected against accumulations of road spray, snow, and road debris.

6.4.4.1 The batteries shall be readily accessible for examination, testing, and maintenance.

6.4.4.2 A means shall be provided for jump-starting the engine if the batteries are not accessible without lifting the cab of a tilt-cab apparatus.

6.4.4.3* Where an enclosed battery compartment is provided, it shall be ventilated to the exterior to prevent the buildup of heat and explosive fumes.

6.4.4.4 The batteries shall be protected against vibration and temperatures that exceed the battery manufacturer's recommendation.

6.4.5* A master body disconnect switch shall be provided to disconnect all electrical loads not provided by the chassis manufacturer.

6.4.5.1 The starter solenoids shall be connected directly to the batteries.

6.4.5.2 Electronic control systems and similar devices shall be permitted to be directly connected to the batteries if so specified by their manufacturer.

6.4.5.3 Rechargeable handlights, radios, and other similar devices shall be permitted to be connected to the electrical system ahead of the master body disconnect switch.

6.4.5.4 The alternator shall be wired directly to the batteries through the ammeter shunt(s) if one is provided.

6.4.5.5 A green "Master Body Disconnect On" indicator that is visible from the driver's position shall be provided.

6.4.6* A sequential switching device shall be permitted to energize the optical warning devices required in 6.3.3 and other high-current devices, provided the switching device shall first energize the electrical devices required in 6.3.3 within 5 seconds.

6.4.7* If an onboard conditioner or charger is supplied, the associated line-voltage electrical power system shall be installed in accordance with NFPA 1901, Chapter 23.

6.5 Starting Device.

6.5.1 An electrical starting device shall be provided for the engine.

6.5.2 Where the electrical starting device is operating under maximum load, the voltage drop of the conductors between the battery and the starting device shall be in accordance with SAE J541, *Voltage Drop for Starting Motor Circuits*.

6.6 Temperature Exposure. Any alternator, electrical starting device, ignition wiring, distributor, or ignition coil shall be moisture resistant and protected such that it is not exposed to a temperature that exceeds the component manufacturer's recommendations.

6.7* Electromagnetic Interference. Electromagnetic interference suppression shall be provided, as required, to satisfy the radiation limits specified in SAE J551/2, *Test Limits and Methods of Measurement of Radio Disturbance Characteristics of Vehicles, Motorboats, and Spark-Ignited Engine-Driven Devices*.

6.8* Optical Warning Devices. Each apparatus that responds on public roads as an emergency vehicle by calling for or blocking the right-of-way from other traffic shall have a system of optical warning devices that meets or exceeds the requirements of this section.

6.8.1 If the vehicle is not equipped to call for or block the right-of-way on a public highway, a sign shall be affixed on the dashboard that reads as follows: "This apparatus is not equipped to call for or block right-of-way on public highways."

6.8.2* The optical warning system shall consist of an upper and lower warning level.

6.8.2.1 The requirements for each level shall be met by the warning devices in that particular level without consideration of the warning devices in the other level.

6.8.3 For the purpose of defining and measuring the required optical performance, the upper and lower warning levels shall be divided into four warning zones.

6.8.3.1 The four zones shall be determined by drawing lines through the geometric center of the apparatus at 45 degrees to a line drawn lengthwise through the geometric center of the apparatus.

6.8.3.2 The four zones shall be designated A, B, C, and D in a clockwise direction with zone A to the front of the apparatus. (See Figure 6.8.3.2.)

6.8.4 Each optical warning device shall be installed on the apparatus and connected to the apparatus's electrical system in accordance with the requirements of this standard and the requirements of the manufacturer of the device.

6.8.5 A master optical warning system switch that energizes all of the optical warning devices shall be provided.

6.8.6 The optical warning system on the fire apparatus shall be capable of two separate signaling modes during emergency operations.

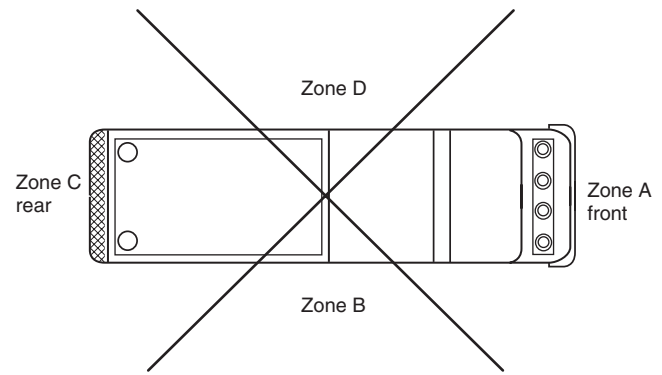


FIGURE 6.8.3.2 Warning Zones for Optical Warning Devices.

6.8.6.1 One mode shall signal to drivers and pedestrians that the apparatus is responding to an emergency and is calling for the right-of-way.

6.8.6.2 One mode shall signal that the apparatus is stopped and is blocking the right-of-way.

6.8.7 A switching system shall be provided that senses the position of the parking brake or the park position of an automatic transmission.

6.8.7.1 When the master optical warning system switch is closed and the parking brake is released or the automatic transmission is not in park, the warning devices signaling the call for the right-of-way shall be energized.

6.8.7.2 When the master optical warning system switch is closed and the parking brake is on or the automatic transmission is in park, the warning devices signaling the blockage of the right-of-way shall be energized.

6.8.7.3* The system shall be permitted to have a method of modifying the two signaling modes.

6.8.8 The optical warning devices shall be constructed or arranged so as to avoid the projection of light, either directly or through mirrors, into any driving or crew compartment(s).

6.8.9 The front optical warning devices shall be placed so as to maintain the maximum possible separation from the headlights.

6.8.10 The optical sources on each level shall be of sufficient number and arranged so that failure of a single optical source does not create a measurement point, in any zone on the same level as the failed optical source, without a warning signal at a distance of 100 ft (30 m) from the geometric center of the apparatus.

6.8.11* Flash Rate.

6.8.11.1 The minimum flash rate of any optical source shall be 75 flashes per minute, and the minimum number of flashes at any measurement point shall be 150 flashes per minute.

6.8.11.1.1 Steady burning nonflashing optical sources shall be permitted to be used.

6.8.11.1.2 The optical energy provided by these nonflashing optical sources shall not be included in the calculations of the zone's total optical power.

6.8.11.2 The flasher of any current-interrupted flashing device shall otherwise meet the requirements of SAE J1690, *Flashers*.

6.8.12* Color of Warning Lights.

6.8.12.1 Permissible colors or combinations of colors in each zone, within the constraints imposed by applicable laws and regulations, shall be as shown in Table 6.8.12.1.

Table 6.8.12.1 Zone Colors

Color	Calling for Right-of-Way	Blocking Right-of-Way
Red	Any zone	Any zone
Blue	Any zone	Any zone
Yellow	Any zone except A	Any zone
White	Any zone except C	Not permitted

6.8.12.2 All colors shall be as specified in SAE J578, *Color Specification*, for red, blue, yellow, or white.

6.8.13* Requirements for Large Apparatus.

6.8.13.1 If an apparatus has a bumper-to-bumper length of 25 ft (7.6 m) or more or has an optical center on any optical warning device greater than 8 ft (2.4 m) above level ground, the requirements of 6.8.13.1 through 6.8.13.6 shall apply.

6.8.13.2 Upper-Level Optical Warning Devices.

6.8.13.2.1 The upper-level optical warning devices shall be mounted as high and as close to the corner points of the apparatus as is practical in order to define the clearance lines of the apparatus.

6.8.13.2.2 The upper-level optical warning devices shall not be mounted above the maximum height specified by the device manufacturer, which gives an intensity value at 4 ft (1.2 m) above level ground and at 100 ft (30.5 m) from the optical warning device, of less than 50 percent of that required at the optical center.

6.8.13.3 Lower-Level Optical Warning Devices.

6.8.13.3.1 In order to define the clearance lines of the apparatus, the optical center of the lower-level optical warning devices in the front of the vehicle shall be mounted forward of the front axle centerline and as close to the front corner points of the apparatus as is practical.

6.8.13.3.2 The optical center of the lower-level optical warning devices at the rear of the vehicle shall be mounted behind the rear axle centerline and as close to the rear corners of the apparatus as is practical.

6.8.13.3.3 The optical center of any lower-level device shall be between 18 in. and 62 in. (460 mm and 1600 mm) above level ground.

6.8.13.4 Midship Optical Warning Devices.

6.8.13.4.1 A midship optical warning device shall be mounted on both the right and left sides of the apparatus if the distance between the front and rear lower-level optical devices exceeds 25 ft (7.6 m) at the optical center.

6.8.13.4.2 Additional midship optical warning devices shall be required, where necessary, to maintain a horizontal distance between the centers of adjacent lower-level optical warning devices of 25 ft (7.6 m) or less.

6.8.13.4.3 The optical center of any midship mounted optical warning device shall be between 18 in. and 62 in. (460 mm and 1600 mm) above level ground.

6.8.13.5* For each operating mode, the combined optical power of all the optical sources shall meet or exceed the zone total optical power requirements shown in Table 6.8.13.5.

6.8.13.6 No individual measurement point shall be less than that shown in Table 6.8.13.5.

6.8.14* Requirements for Small Apparatus.

6.8.14.1 If the apparatus has a bumper-to-bumper length of less than 25 ft (7.6 m) and has the optical center of all optical warning devices at 8 ft (2.4 m) or less above level ground, the requirements of 6.8.14.1 through 6.8.14.5 shall apply.

Table 6.8.13.5 Minimum Optical Power Requirements for Large Apparatus

		Mode of Operation					
		Clearing Right-of-Way			Blocking Right-of-Way		
Zone	Level	H	At any H Point	At any Point 5° Up or 5° Down from H	H	At any H Point	At any Point 5° Up or 5° Down from H
A	Upper	1,000,000	10,000	3,500	400,000	10,000	3,500
B	Upper	400,000	10,000	3,500	400,000	10,000	3,500
C	Upper	400,000	10,000	3,500	800,000	10,000	3,500
D	Upper	400,000	10,000	3,500	400,000	10,000	3,500
A	Lower	150,000	3,750	1,300	150,000	3,750	1,300
B	Lower	150,000	3,750	1,300	150,000	3,750	1,300
C	Lower	150,000	3,750	1,300	150,000	3,750	1,300
D	Lower	150,000	3,750	1,300	150,000	3,750	1,300

Notes:

(1) All values are in candela-seconds/minute.

(2) H = Horizontal plane passing through the optical center.

6.8.14.2 Upper-Level Optical Warning Devices.

6.8.14.2.1 The upper-level optical warning devices shall be mounted as high as practical, but not over 8 ft (2.4 m), at the optical center.

6.8.14.2.2 The upper-level optical warning devices shall be permitted to be combined in one or more enclosures and shall be permitted to be mounted on the cab roof or any other convenient point.

6.8.14.3 Lower-Level Optical Warning Devices.

6.8.14.3.1 One or more lower-level optical warning devices shall be visible from the front and the side of the apparatus.

6.8.14.3.2 The optical center of the lower-level optical warning devices in the front of the vehicle shall be mounted forward of the front wheel centerline and as close to the front corner points of the apparatus as is practical.

6.8.14.3.3 The optical center of the device(s) shall be between 18 in. and 48 in. (460 mm and 1220 mm) above level ground.

6.8.14.4 For each operating mode, the combined optical power of all the optical sources mounted on both the upper and lower levels shall meet or exceed the zone's total optical power requirements shown in Table 6.8.14.4.

6.8.14.5 No individual measurement point shall be less than that shown in Table 6.8.14.4.

6.8.15 Tests of Optical Warning Devices.**6.8.15.1 Mechanical and Environmental Tests.**

6.8.15.1.1 All optical warning devices shall be tested to the requirements of SAE J595, *Directional Flashing Optical Warning Devices for Authorized Emergency, Maintenance, and Service Vehicles*, SAE J845, *360 Degree Warning Devices for Authorized Emergency, Maintenance, and Service Vehicles*, SAE J1318, *Gaseous Discharge Warning Lamp for Authorized Emergency, Maintenance, and Service Vehicles*, or SAE J1889, *L.E.D. Signal and Marking Lighting Devices*.

6.8.15.1.2 Optical devices and components designed for mounting only in weatherproof, interior spaces shall be tested in conformance with the applicable SAE standard listed in 6.8.15.1.1 and shall comply with the vibration test and the warpage test for plastic components.

6.8.15.1.3 Optical devices and components designed for mounting on the exterior of the apparatus or in nonweatherproof interior spaces shall be tested in conformance with SAE J845 and shall comply with the following performance requirements of that standard:

- (1) Vibration
- (2) Moisture
- (3) Dust
- (4) Corrosion
- (5) High temperature
- (6) Low temperature
- (7) Durability
- (8) Warpage

6.8.15.2 Photometric Test Procedures for Optical Devices.

6.8.15.2.1 Testing shall be performed by, or on behalf of, the device manufacturer to ensure compliance with the requirements of 6.8.15.2.2 through 6.8.15.2.5.2.

6.8.15.2.1.1 The results of the testing shall be used by the apparatus builder or purchaser to determine compliance with this standard and all required photometric data shall be available upon request from the optical warning device manufacturer.

6.8.15.2.1.2 The goniometer, integrating photometer, and other equipment used to take the test measurements shall meet the requirements of SAE J1330, *Photometry Laboratory Accuracy Guidelines*.

6.8.15.2.2 The optical source shall be mounted in a goniometer and operated as it would be in a normal system application.

6.8.15.2.2.1 The minimum distance between the light emitting surface of the source being tested and the front face of the photometer detector shall be 59 ft (18 m).

6.8.15.2.2.2 The goniometer shall be oriented and the integrating photometer shall be set to integrate light pulses from the source for 20 seconds.

6.8.15.2.3 For all tests performed with the power applied, the lighting system, or component thereof, shall be operated at $12.8\text{ V} \pm 0.1\text{ V}$ for 12 V rated equipment and $25.6\text{ V} \pm 0.2\text{ V}$ for 24 V rated equipment.

Table 6.8.14.4 Minimum Optical Power Requirements for Small Apparatus

Mode of Operation						
Clearing Right-of-Way				Blocking Right-of-Way		
Zone	H	At any H Point	At any Point 5° Up or 5° Down from H	H	At any H Point	At any Point 5° Up or 5° Down from H
A	1,000,000	10,000	3,500	400,000	10,000	3,500
B	200,000	8,000	3,500	200,000	8,000	3,500
C	400,000	10,000	3,500	800,000	10,000	3,500
D	200,000	8,000	3,500	200,000	8,000	3,500

Notes:

(1) All values are in candela-seconds/minute.

(2) H = Horizontal plane passing through the optical center.

6.8.15.2.3.1 If the equipment is rated for operation on both 12 V and 24 V, the tests shall be performed at both voltages.

6.8.15.2.3.2 Voltage shall be measured at a point 12 in. $\pm$ 1 in. (300 mm $\pm$ 25 mm) from the entry into the component.

6.8.15.2.4 The technique described in 6.8.15.2.2 through 6.8.15.2.2.2 shall be performed along the horizontal plane that passes through the optical center beginning at the optical center and repeated at 5 degree intervals to the left and right of the optical center throughout the active horizontal angle of light emission of the optical source.

6.8.15.2.5 Measurements shall be repeated at 5 degrees up and 5 degrees down from the horizontal plane that passes through the optical center, beginning at a point on a line passing through the optical center, and perpendicular to the horizontal plane.

6.8.15.2.5.1 The measurements shall be repeated at 5 degree intervals to the left and right of this vertical line throughout the active horizontal angle of light emission of the optical source.

6.8.15.2.5.2 If the optical warning device contains more than one optical source, the test shall be repeated for each optical source.

6.8.16* Compliance Documentation. The apparatus manufacturer shall demonstrate compliance of the warning system by one of the following methods:

- (1) Certification that the system was installed within the geometric parameters specified by the manufacturer of the system, referencing the optical source test reports provided by the manufacturer of the system.
- (2) Certification that a mathematical calculation based on test reports for individual optical sources provided by the manufacturer of the devices and performed by a qualified person demonstrates that the combination of individual devices as installed meets the requirements of this standard.
- (3) Actual measurement of the lighting system after installation on the apparatus.

6.9 Audible Warning Devices.

6.9.1 Audible warning equipment in the form of at least one automotive traffic horn shall be provided.

6.9.2* If the apparatus responds as an emergency vehicle on public roads, one electric or electronic siren shall be provided.

6.9.2.1 The siren manufacturer shall certify the siren as meeting the requirements of SAE J1849, *Emergency Vehicle Sirens*.

6.9.2.2 A means shall be provided to allow the activation of the siren within convenient reach of the driver.

6.9.3 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 is practical.

6.9.4 Audible warning equipment shall not be mounted on the roof of the apparatus.

6.10* Work Lighting. The purchaser shall specify any work lighting required for the mission of the fire apparatus.

6.11 Backup Alarm. An electric or electronic backup alarm shall be provided that meets the Type D (87 dBA) requirements of SAE J994, *Alarm — Backup — Electric, Laboratory Performance Testing*.

6.12 Stop, Tail, and Directional Lights.

6.12.1 The apparatus shall be equipped with all legally required stop, tail, and directional lights.

6.12.2 Directional lights shall be visible from the front, sides, and rear of the apparatus.

6.12.3 On apparatus 30 ft (10 m) or longer in length, a turn signal shall be mounted approximately midway along the apparatus at approximately running board height.

6.12.4 Equipment shall not be mounted in a manner that obscures the stop, tail, or directional lights.

6.13 Electrical System Performance Tests.

6.13.1* The fire apparatus low-voltage electrical system shall be tested as required by this section and the test results certified by the apparatus manufacturer. The certification shall be delivered to the purchaser with the apparatus.

6.13.2 Tests shall be performed when the air temperature is between 0°F and 110°F (–18°C and 43°C).

6.13.3 Test Sequence.

6.13.3.1 The three tests defined in 6.13.3.2 through 6.13.3.4 shall be performed in the order in which they appear.

6.13.3.1.1 Before each test, the batteries shall be fully charged until the voltage stabilizes at the voltage regulator set point and the lowest charge current is maintained for 10 minutes.

6.13.3.1.2 Failure of any of these tests shall require a repeat of the sequence.

6.13.3.2 Reserve Capacity Test.

6.13.3.2.1 The engine shall be started and kept running until the engine and engine compartment temperatures are stabilized at normal operating temperatures and the battery system is fully charged.

6.13.3.2.2 The engine shall be shut off, and the minimum continuous electrical load shall be activated for 10 minutes.

6.13.3.2.3 All electrical loads shall be turned off prior to attempting to restart the engine.

6.13.3.2.4 The battery system shall then be capable of restarting the engine.

6.13.3.2.5 Failure to restart the engine shall be considered a test failure of the battery system.

6.13.3.3 Alternator Performance Test at Idle.

6.13.3.3.1 The minimum continuous electrical load shall be activated with the engine running at idle speed.

6.13.3.3.2 The engine temperature shall be stabilized at normal operating temperature.

6.13.3.3.3 The battery system shall be tested to detect the presence of battery discharge current.

6.13.3.3.4 The detection of battery discharge current shall be considered a test failure.

6.13.3.4 Alternator Performance Test at Full Load.

6.13.3.4.1 The total continuous electrical load shall be activated with the engine running up to the engine manufacturer's governed speed.

6.13.3.4.2 The test duration shall be a minimum of 2 hours.

6.13.3.4.3 Activation of the load management system shall be permitted during this test.

6.13.3.4.4 An alarm sounded by excessive battery discharge as detected by the warning system required in 6.3.4, or a system voltage of less than 11.8 V dc for a 12 V nominal system or 23.6 V dc for a 24 V nominal system, for more than 120 seconds, shall be considered a test failure.

6.13.4 Low-Voltage Alarm Test.

6.13.4.1 The following test shall be started with the engine off and the battery voltage at or above 12 V for a 12 V nominal system or 24 V for a 24 V nominal system.

6.13.4.2 With the engine shut off, the total continuous electrical load shall be activated and shall continue to be applied until the excessive battery discharge alarm activates.

6.13.4.3 The battery voltage shall be measured at the battery terminals.

6.13.4.4 The test shall be considered a failure if the alarm has not yet sounded 140 seconds after the voltage drops to 11.70 V for a 12 V nominal system or 23.4 V for a 24 V nominal system.

6.13.4.5 The battery system shall then be able to restart the engine.

6.13.4.6 Failure to restart the engine shall be considered a test failure.

6.14 Documentation. At the time of delivery, the manufacturer shall provide the following:

- (1) Documentation of the electrical system performance tests
- (2) A written electrical load analysis, including the following:
 - (a) The nameplate rating of the alternator
 - (b) The alternator rating under the conditions specified in 6.3.2
 - (c) Each of the component loads specified in 6.3.3 that make up the minimum continuous electrical load
 - (d) Additional electrical loads that, when added to the minimum continuous electrical load, determine the total continuous electrical load
 - (e) Each individual intermittent electrical load

Chapter 7 Driving and Crew Areas

7.1 General.

7.1.1 Each crew riding position shall be within a fully enclosed personnel area.

7.1.2 A label that states the number of personnel the vehicle is designed to carry shall be located in an area visible to the driver.

7.1.3* Each crew riding position shall be provided with a seat and an approved seat belt designed to accommodate a person with or without heavy clothing.

7.1.3.1 If available from the chassis manufacturer, the seat belt webbing shall be bright red in color and the buckle portion of the seat belt shall be mounted on a rigid or semirigid stalk such that the buckle remains positioned in an accessible location.

7.1.3.2 All forward-facing seats adjacent to a side wall shall be provided with a Type 2 pelvic and upper torso restraint-style seat belt assembly conforming to the Federal Motor Vehicle Safety Standard (FMVSS) No. 209, "Seat belt assemblies."

7.1.3.3 All seat belt assembly anchorages shall conform to the Federal Motor Vehicle Safety Standard (FMVSS) No. 210, "Seat belt assembly anchorages."

7.1.3.4 Signs that read "Occupants must be seated and belted when apparatus is in motion" shall be visible from each seated position.

7.1.3.5 Each seating position that is not intended to be used during transit shall be individually labeled as follows:

WARNING: THIS SEAT IS NOT TO BE OCCUPIED WHILE VEHICLE IS IN MOTION.

7.1.3.6 If available from the chassis manufacturer, a seat belt warning device shall be provided.

7.1.3.6.1 The warning device shall consist of an audible alarm that can be heard at all seating positions designed to be occupied while the vehicle is in motion, or a flashing light or lights visible from the driver's seat and the officer's seat.

7.1.3.6.2 The warning device shall be activated any time the parking brake is released or the automatic transmission is not in park or in neutral, and the seat belt of any occupied seat is not fastened or the seat belt of any unoccupied seat is fastened.

7.1.4 Materials used within the driving and crew compartment(s) shall comply with Federal Motor Vehicle Safety Standard (FMVSS) No. 302, "Flammability of interior materials."

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

7.1.6 All driving and crew compartment doors shall have at least 96 in.² (62,000 mm²) of reflective material affixed to the inside of each door.

7.1.7 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 49 CFR 393.94(c), "Vehicular interior noise levels test procedure," except that the test shall be performed with the vehicle traveling at a steady speed of 45 mph (72 km/hr) on a level, paved, smooth surface road.

7.1.8 Seat Head Height.

7.1.8.1* The minimum vertical dimension from the seat H-point to the ceiling for each belted seating position shall be as follows:

- (1) For suspension-style seats with independent height adjustment, the minimum vertical dimension shall be 37 in. (940 mm) measured with the height adjustment in its lowest position and the suspension inflated and/or raised to the upper limit of its travel.
- (2) For suspension-style seats without independent height adjustment, the minimum vertical dimension shall be 37 in. (940 mm) measured with the suspension inflated and/or raised to the upper limit of its travel.
- (3) For nonsuspension-style seats, the minimum vertical dimension shall be 35 in. (882 mm) measured with the seat adjusted to its lowest position.

7.1.8.2 When independent vertical and/or horizontal seat adjustment is provided, it shall be fully adjustable within 10 seconds.

7.1.8.3 The seat-to-ceiling height shall be measured at the lowest surface in the area immediately above the projected area of the seat as it is moved through its horizontal travel with any soft headliner material depressed by hand.

7.1.9 Seat Arrangement.

7.1.9.1 Each seating space shall have a minimum width of 22 in. (560 mm) at the shoulder level.

7.1.9.2 Seat cushions shall be a minimum of 18 in. (460 mm) in width and 15 in. (380 mm) from the front of the cushion to the face of the seatback.

7.1.9.3 A back cushion that extends from the face of the seat vertically at least 18 in. (460 mm) and that is a minimum of 18 in. (460 mm) wide shall be provided.

7.1.9.3.1 The back cushion shall be permitted to be split to accommodate a fully recessed SCBA and bracket.

7.1.9.3.2 Where the back cushion is split to accommodate an SCBA, a headrest shall be supplied.

7.1.10 SCBA Mounting.

7.1.10.1* Where SCBA units are mounted within a driving or crew compartment, a positive latching mechanical means of holding the SCBA device in its stowed position shall be provided such that the SCBA unit cannot be retained in the mount unless the positive latch is engaged.

7.1.10.2 The bracket-holding device and its mounting shall retain the SCBA unit when subjected to a 9 G force and shall be installed in accordance with the bracket manufacturer's requirements.

7.1.10.3 If the SCBA unit is mounted in a seatback, the release mechanism shall be accessible to the user while seated.

7.1.11 Equipment Mounting.

7.1.11.1 All equipment required to be used during an emergency response shall be securely fastened.

7.1.11.2 All equipment not required to be used during an emergency response, with the exception of SCBA units, shall not be mounted in a driving or crew area unless it is contained in a fully enclosed and latched compartment capable of containing the contents when a 9 G force is applied in the longitudinal axis of the vehicle or a 3 G force is applied in any other direction, or the equipment is mounted in a bracket(s) that can contain the equipment when the equipment is subjected to those same forces.

7.1.12 Steps and access handrails that comply with 8.6.1, 8.6.2, 8.6.3, and Section 8.7 shall be provided as necessary for access to all driving and crew compartments.

7.1.13 Where the crew compartment and the driving compartment are separated, prohibiting direct voice communication, a two-way buzzer or two-way voice intercom system shall be provided.

7.1.14 Means of Escape.

7.1.14.1 Any interior area to be occupied by personnel shall have a minimum of two means of escape.

7.1.14.2 Each opening designed to be an emergency means of escape shall be large enough for a person up to the 95th percentile male as defined in SAE J833, *Physical Human Dimensions*, to escape through.

7.2 Cab Tilt Systems. If the fire apparatus has a cab tilt system, the system shall meet the requirements of 7.2.1 through 7.2.3.2.

7.2.1 If the operation of the cab tilt system is accomplished by hydraulic means, the system shall be equipped with devices to prevent the motion of the cab in the event of any hydraulic hose failure.

7.2.2 If the cab has a powered tilting system, the system shall be interlocked to operate only when the parking brake is engaged and shall be configured so that the failure of a single component will not result in unintentional tilting of the cab.

7.2.3 The control of the cab tilt mechanism shall be accomplished clear of the cab travel area while still having the travel area in clear view.

7.2.3.1 A mechanical means shall be provided to hold the cab in a fully raised position.

7.2.3.2 If the cab is able to be raised to a defined intermediate position, a mechanical means shall also be provided to hold the cab in that intermediate position.

7.3 Driving Compartment.

7.3.1* A fully enclosed driving compartment with seating capacity for not less than two persons shall be provided.

7.3.2 Driver's Seat.

7.3.2.1 The driver's seat shall be readily adjustable by the driver.

7.3.2.2 The seat shall be arranged to accommodate a human conforming to at least the fifth percentile female through 95th percentile male as defined in SAE J833.

7.3.3* The passenger side mirror shall be so mounted that the driver has a clear view of the mirror when the passengers are in their normal seated positions.

7.3.4 Instrumentation and Controls.

7.3.4.1* The following instrumentation and controls shall be mounted in the driving compartment and shall be identified and visible to the driver while seated:

- (1) Speedometer
- (2) Odometer
- (3) Oil pressure indicator or gauge
- (4) Coolant temperature indicator or gauge
- (5) Automatic transmission temperature indicator or gauge, if applicable and available
- (6) Voltmeter
- (7) Air pressure gauge(s), if applicable
- (8) Turn signal control and indicator lights
- (9) Headlight/DOT light switch
- (10) High-beam headlight switch and indicator
- (11) Fuel level gauge(s)
- (12) Heater/defroster controls
- (13) Warning lights and siren switches, if applicable
- (14) "Master body disconnect on" indicator light
- (15) Windshield wipers and windshield washer control
- (16) PTO-engaged indicator, if applicable
- (17) Pump engagement controls, if applicable

7.3.4.2 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.

Chapter 8 Body, Compartments, and Equipment Mounting

8.1 Compartmentation.

8.1.1* Any enclosed external compartments shall be weather resistant.

8.1.2 All electrical junctions or wiring within compartments shall be protected from mechanical damage resulting from equipment stored in the compartment.

8.2* Equipment Containment.

8.2.1 Equipment holders or compartments shall be provided for all tools, equipment, and other items that are on the fire apparatus.

8.2.2* Equipment holders shall be attached and shall be designed so that equipment remains in place under all vehicle operating conditions.

8.2.3 All tools and equipment shall be readily accessible.

8.3 Powered Equipment Racks. When a powered equipment rack is provided, it shall meet the requirements of this section.

8.3.1 The equipment rack shall be constructed of materials that are capable of carrying the equipment that is intended to be mounted on the equipment rack.

8.3.2 A lock shall be provided that will retain the equipment rack in the road travel position when the vehicle is in motion.

8.3.3 An interlock shall be provided to prevent operation of the equipment rack unless the apparatus parking brake has been activated.

8.3.4 Controls shall be provided in a position where the operator can visually follow the travel of the equipment rack.

8.3.5 A visual signal shall be provided at the driver's position to indicate that the equipment rack is in motion, or in the down position, and that the parking brake is not engaged.

8.3.6 Flashing lights facing the front and rear of the apparatus shall be provided on the equipment rack and shall be illuminated whenever the equipment rack is in the down position.

8.3.7 The outward ends of the equipment rack that protrude beyond the body of the apparatus shall have reflective material to indicate a hazard or obstruction.

8.4* SCBA Storage. Storage of complete SCBA units or SCBA cylinders shall be arranged so as to prevent damage, injury, or abrasion to the SCBA from other equipment stored in the general area.

8.4.1 If an SCBA unit or cylinder is stored within a driving or crew compartment, the mounting shall comply with the requirements of Section 8.4 and 7.1.10.

8.4.2 If an SCBA cylinder is mounted in a vertical position with the valve down, it shall be supported with a brace or yoke under the cylinder or valve area to prevent downward movement.

8.4.3 The holding or clamping device shall not injure, wear, scrape, or otherwise affect the SCBA unit or cylinder, including damage to the paint or reflective finish, while the cylinder is being placed in, stored in, or removed from the holder.

8.4.4 The SCBA storage area shall be a ventilated, dry area away from all heat sources that could damage the SCBA (e.g., mufflers, engines).

8.4.5* Vertical Storage of SCBA Cylinders in Tubes.

8.4.5.1 The base of the storage tube shall have a rubber, plastic, or similar device to prevent wear on the cylinder and to prevent damage if the cylinder is accidentally dropped into the storage position.

8.4.5.2 Each storage tube shall have a drain to prevent accumulation of moisture.

8.4.6* Horizontal Storage of SCBA Cylinders.

8.4.6.1 The storage rack or tube assembly shall be designed to prevent the cylinder from accidentally sliding out of the storage rack or tube and shall be installed so as to keep the cylinder from hitting or rubbing on compartment doors, by preventing movement or shifting when in transit.

8.4.6.2 The rear wall of each SCBA storage area or tube shall be covered with a rubber, plastic, or similar material to prevent wear on cylinders.

8.5 Pump and Plumbing Access. If the water pump on the wildland fire apparatus is in an enclosed space, the requirements of 8.5.1 through 8.5.5 shall apply.

8.5.1 One or more doors or panels that open or are removable without the use of tools shall be provided to allow visual inspection or access for checking the water pump and plumbing area.

8.5.2 The clear opening shall have no one dimension measure less than 18 in. (460 mm).

8.5.3 Additional door(s) or panel(s) that require no more than standard tools to be opened or removed shall be provided for access to the pump and plumbing area.

8.5.4 All valves, gauges, controls, and other plumbing equipment shall be accessible for service and replacement.

8.5.5* The clear space required by the pump manufacturer to perform in-truck overhaul and maintenance shall be provided.

8.6 Stepping, Standing, and Walking Surfaces.

8.6.1* Steps, platforms, or permanently attached ladders shall be provided so that fire fighters have access to all working and storage areas of the fire apparatus.

8.6.1.1 The maximum stepping height shall not exceed 18 in. (460 mm), with the exception of the ground to first step, which shall not exceed 24 in. (610 mm).

8.6.1.1.1 When it is not possible to maintain the minimum or specified angle of departure using a fixed rear step with the ground-to-first-step height not exceeding 24 in. (610 mm), the first step shall be designed to be movable so as not to be damaged when the vehicle traverses terrain that requires the full angle of departure.

8.6.1.1.2 The ground-to-first-step height shall be determined with the apparatus on level ground.

8.6.1.2* All steps shall have a minimum area of 35 in.² (22,580 mm²), shall be of such a shape that a 5 in. (125 mm) diameter disk does not overlap any side when placed on the step, and shall be arranged to provide at least 8 in. (200 mm) of clearance between the leading edge of the step and any obstruction.

8.6.1.3 All platforms shall have a minimum depth of 8 in. (200 mm) from the leading edge of the platform to any obstruction.

8.6.1.4 All ladders shall have at least 7 in. (175 mm) of clearance between any rung and the body of the apparatus or other obstruction.

8.6.2 All steps, platforms, or ladders shall be designed and installed to sustain a minimum static load of 500 lb (227 kg) without deformation.

8.6.3* Slip Resistance.

8.6.3.1 All materials used for exterior surfaces designated as stepping, standing, and walking areas and all interior steps shall have a minimum slip resistance in any orientation of 0.68 when tested wet using the English XL tester in accordance with ASTM F 1679, *Standard Test Method for Using a Variable Incidence Tribometer (VIT)*, or 0.52 when tested wet using the Brungraber Mark II tester in accordance with ASTM F 1677, *Standard Test Method for Using a Portable Inclined Articulated Strut Slip Tester (PIAST)*.

8.6.3.2 All materials used for interior floors shall have a minimum slip resistance in any orientation of 0.58 when tested dry using the English XL tester in accordance with ASTM F 1679 or 0.47 when tested dry using the Brungraber Mark II tester in accordance with ASTM F 1677.

8.6.3.3 A standard Neolite® test sensor shall be used with both the English XL tester and the Brungraber Mark II tester.

8.6.3.4 Sampling Strategy.

8.6.3.4.1 For uniformly patterned materials, at least 16 readings shall be taken on each sample.

8.6.3.4.1.1 Each reading shall be taken 90 degrees clockwise from the previous orientation, resulting in at least four readings in each orientation.

8.6.3.4.1.2 The readings shall be averaged and reported as the slip resistance for the material.

8.6.3.4.2 For directionally patterned materials, at least 32 readings shall be taken on each sample.

8.6.3.4.2.1 Each reading shall be taken 45 degrees clockwise from the previous orientation, resulting in at least four readings in each orientation.

8.6.3.4.2.2 The four readings in each direction shall be averaged and reported as the slip resistance for the material in that orientation.

8.6.3.5 The contractor shall supply at the time of delivery of the apparatus, a certification that all materials used for exterior surfaces designated as stepping, standing, and walking areas; all interior steps; and all interior floors meet the requirements of 8.6.3.

8.6.3.6 Where the fuel fill is located at or near a stepping surface, the surface shall be constructed of an open grate-type material to facilitate draining of accidentally spilled fuel to lessen any slipping hazard.

8.6.4 A sign shall be located on the vehicle at the rear step areas and at any cross walkways to warn personnel that riding in or on these areas while the vehicle is in motion is prohibited.

8.7* Access Handrails.

8.7.1 Access handrails shall be provided at each entrance to a driving or crew compartment and at each position where steps or ladders for climbing are located.

8.7.2 Exterior access handrails shall be constructed of or covered with a slip-resistant, noncorrosive material.

8.7.3 Exterior access handrails shall be between 1 in. and 1½ in. (25 mm and 42 mm) in diameter and have a minimum clearance between the handrails and any surface of at least 2 in. (50 mm).

8.7.4 All exterior access handrails shall be designed and mounted to reduce the possibility of hand slippage and to avoid snagging of hose, equipment, or clothing.

8.7.5* Access handrails supplied by the chassis manufacturer on a commercial chassis shall be permitted to be used to meet the requirements of this section.

8.8 Metal Finish.

8.8.1 Where dissimilar metals that pose a galvanic corrosion or reactive threat are to be mounted together, the mounting base material shall have an isolation barrier prior to assembly to prevent dissimilar metal reaction.

8.8.2* Painting.

8.8.2.1* All exposed ferrous metal surfaces that are not plated or stainless steel shall be cleaned and prepared and shall be painted or coated.

8.8.2.2 The paint or coating, including any primer, shall be applied in accordance with the paint or coating manufacturer's recommendation.

8.8.3 A reflective stripe(s) shall be affixed to the perimeter of the apparatus.

8.8.3.1 The stripe, or combination of stripes, shall be a minimum of 4 in. (100 mm) in total width and shall conform to the minimum requirements of ASTM D 4956, *Standard Specification for Retroreflective Sheeting for Traffic Control*, Type I, Class 1 or Class 3.

8.8.3.2* At least 50 percent of the cab and body length on each side, at least 50 percent of the width of the rear, and at least 25 percent of the width of the front of the apparatus shall have the reflective material affixed to it.

8.8.3.3 A graphic design meeting the reflectivity requirements of 8.8.3.1 shall be permitted to replace all or part of the required striping material, if the design or combination thereof covers at least the same perimeter length(s) required by 8.8.3.2.

8.9 Hose Storage. If a hose storage area(s) is provided, it shall comply with this section.

8.9.1* The hose storage area(s) shall be reinforced at the corners.

8.9.2 The bottom shall be made of removable sections fabricated from noncorrosive materials.

8.9.3* The bottom shall be constructed to prevent the accumulation of water and allow for ventilation to aid in drying hose.

8.9.4 The interior shall be smooth and free from all projections, such as nuts, sharp angles, or brackets, that might cause damage to the hose.

8.9.5 Reels, handrails, ladders, and equipment holders shall be placed so as not to obstruct the laying or removal of hose from the storage area.

8.9.6 If suction hose is to be carried, space shall be provided for carrying the suction hose.

8.9.7* Any hose storage area shall be equipped with a positive means to prevent unintentional deployment of the hose from the top, sides, front, and rear of the hose storage area while the apparatus is underway in normal operations.

8.9.8* If a hose reel is provided, it shall be equipped with a brake.

8.9.8.1 The hose reel shall have a capacity of not less than 100 ft (30 m) of $\frac{3}{4}$ in. (19 mm) booster hose.

8.9.8.2 When the reel is equipped with over 100 ft (30 m) of hose, the reel shall have power rewind capability.

8.10* Receivers and Anchors for Rope and Removable Winches.

8.10.1 Receivers or anchors installed at any location on the apparatus for use as removable winch anchors shall be designed and affixed to provide at least a 1.5-to-1 safety factor over the load rating of the removable winch.

8.10.2 Receivers or anchors installed at any location on the apparatus for use with rope operations shall be designed and affixed to the apparatus to provide at least a 5-to-1 safety factor over the breaking strength of the rope that will be used.

8.10.3 A label shall be placed on or near each receiver or anchor that states the maximum winch load rating and the maximum rope load rating that the receiver or anchor can support.

8.11 Slip-On Fire-Fighting Module. If the pump, piping, and tank are built as a slip-on, self-contained module, it shall meet the requirements of 8.11.1 through 8.11.3 and be mounted on the fire apparatus in accordance with 8.11.4.

8.11.1 The major components of the slip-on module including the pump, pumping engine, water and agent tank(s), plumbing system, and electrical system shall meet the requirements of the applicable chapters of this standard covering those components.

8.11.2 Intake and discharge piping shall not interfere with the routine maintenance of the pump, engine, or auxiliary systems and shall not unduly restrict the servicing of these components.

8.11.3 The manufacturer of a slip-on fire-fighting module shall provide the following data with the module:

- (1) Weight without water but with all other tanks or reservoirs for liquids full
- (2) Weight full of water and other liquids including foam concentrate, fuel, and lubricants
- (3) Horizontal center of gravity when full of water and other liquids
- (4) Overall dimensions

8.11.4 Mounting.

8.11.4.1 The slip-on module shall be mounted in a manner that allows access to the engine, pump, and auxiliary systems for routine maintenance.

8.11.4.2 The slip-on module shall be removable using common hand tools.

8.11.4.3 The slip-on module shall be mounted in a manner that prevents damage by vibration.

8.11.4.4* Special anchorage shall be provided on the vehicle chassis and on the slip-on fire-fighting module to secure the fire-fighting module to the vehicle chassis.

8.11.4.5 The anchorage described in 8.11.4.4 shall be designed to prevent movement of the slip-on module during rapid acceleration, deceleration, or side-hill operations.

8.11.4.6 No drilling on chassis frame flanges or welding to chassis frame shall be permitted.

Chapter 9 Water Pumps

9.1 Performance Requirements. Water pumps on wildland fire apparatus shall be classified in one of the following categories:

- (1) 100 psi (700 kPa) positive displacement pump
- (2) 100 psi (700 kPa) centrifugal pump
- (3) 150 psi (1000 kPa) centrifugal pump
- (4) 200 psi (1400 kPa) centrifugal pump
- (5) 250 psi (1700 kPa) centrifugal pump
- (6) 300 psi (2100 kPa) centrifugal pump
- (7) 400 psi (2800 kPa) centrifugal pump

9.1.1 If the water pump is a positive displacement design, it shall be rated at 10 gpm (38 L/min) at 100 psi (700 kPa).

9.1.2 If the water pump is to be classified as a 100 psi (700 kPa) centrifugal pump, it shall be capable of delivering one of the flow ratings shown in Table 9.1.2 at 100 psi (700 kPa) net pump pressure and the corresponding flow at 65 psi (450 kPa) net pump pressure.

9.1.3 If the water pump is to be classified as a 150 psi (1000 kPa) centrifugal pump, it shall be capable of delivering one of the flow ratings shown in Table 9.1.3 at 150 psi (1000 kPa) net pump pressure and the corresponding flow at 65 psi (450 kPa) net pump pressure.

Table 9.1.2 Rating Points for a Pump Classified as a 100 psi (700 kPa) Centrifugal Pump

65 psi (450 kPa) net		100 psi (700 kPa) net	
gpm	L/min	gpm	L/min
25	95	10	38
70	265	30	115
100	375	50	190
135	510	70	265
225	850	100	375

Table 9.1.3 Rating Points for a Pump Classified as a 150 psi (1000 kPa) Centrifugal Pump

65 psi (450 kPa) net		150 psi (1000 kPa) net	
gpm	L/min	gpm	L/min
70	265	40	150
150	568	50	190

9.1.4 If the water pump is to be classified as a 200 psi (1400 kPa) centrifugal pump, it shall be capable of delivering one of the flow ratings shown in Table 9.1.4 at 200 psi (1400 kPa) net pump pressure and the corresponding flow at 100 psi (700 kPa) net pump pressure.

Table 9.1.4 Rating Points for a Pump Classified as a 200 psi (1400 kPa) Centrifugal Pump

100 psi (700 kPa) net		200 psi (1400 kPa) net	
gpm	L/min	gpm	L/min
110	416	55	208
200	750	100	375
220	832	150	568

9.1.5 If the water pump is to be classified as a 250 psi (1700 kPa) centrifugal pump, it shall be capable of delivering 150 gpm (568 L/min) at 250 psi (1700 kPa) net pump pressure and 250 gpm at 150 psi (1000 kPa) net pump pressure.

9.1.6 If the water pump is to be classified as a 300 psi (2100 kPa) centrifugal pump, it shall be capable of delivering one of the flow ratings shown in Table 9.1.6 at 300 psi (2100 kPa) net pump pressure and the corresponding flow at 150 psi (1000 kPa) net pump pressure.

Table 9.1.6 Rating Points for a Pump Classified as a 300 psi (2100 kPa) Centrifugal Pump

150 psi (1000 kPa) net		300 psi (2100 kPa) net	
gpm	L/min	gpm	L/min
25	95	10	38
40	150	15	56
100	375	50	190
200	750	100	375
400	1520	200	750
500	1900	200	750

9.1.7 If the water pump is to be classified as a 400 psi (2800 kPa) centrifugal pump, it shall be capable of delivering one of the flow ratings shown in Table 9.1.7 at 400 psi (2800 kPa) net pump pressure and the corresponding flow at 150 psi (1000 kPa) net pump pressure.

Table 9.1.7 Rating Points for a Pump Classified as a 400 psi (2800 kPa) Centrifugal Pump

150 psi (1000 kPa) net		400 psi (2800 kPa) net	
gpm	L/min	gpm	L/min
25	95	10	38
40	150	15	56
100	375	50	190
200	750	100	375
400	1520	200	750
500	1900	250	950

9.2* Pumping Suction Capability. The pump manufacturer shall certify that the pump can deliver its rated capacity at rated net pump pressure from draft, under the following conditions:

- (1) An altitude of 2000 ft (600 m) above sea level
- (2) Through a single intake with 20 ft (6 m) of suction hose of the size specified in Table 9.2(a) and equipped with a suction hose strainer
- (3) With a lift of 10 ft (3 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)
- (6) Entrance and friction loss for the 20 ft of suction hose and strainer listed in Table 9.2(b) or entrance and friction loss for the 6 m of suction hose and strainer listed in Table 9.2(c)

Table 9.2(a) Suction Hose Size by Rated Capacity

Flow Rate		Suction Hose Size	
gpm	L/min	in.	mm
10	38	1½	38
15	56	1½	38
30	115	1½	38
40	150	2	51
50	190	2	51
55	208	2	51
70	265	2	51
100	375	2½	65
150	568	3	75
200	750	4	100
250	950	4	100

9.3 Priming.

9.3.1* When dry, the pump system (in both parallel and series operation where pumps are of the parallel/series type) shall be capable of taking suction under the conditions specified in Section 9.2 through 20 ft (6 m) of suction hose of the size specified in Table 9.2(a) and a strainer, and discharging water in not more than 30 seconds.

9.3.2 Priming System.

9.3.2.1* The priming system shall use one of the following priming methods:

- (1) Prime from the intake with the pump running
- (2) Prime from the discharge with the pump not running

9.3.2.2 The priming device shall be capable of operating with no lubricant or with a biodegradable nontoxic lubricant.

9.3.3 Vacuum.

9.3.3.1 The completed pumping system shall be capable of developing a vacuum of 17 in. Hg (57.4 kPa) at an altitude of 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).

9.3.3.2 The requirement in 9.3.3.1 shall be met with all intake valves open, all intakes capped or plugged, all discharge caps removed, and without the use of the priming device during the 5-minute period.

Table 9.2(b) Friction and Entrance Loss in 20 ft of Suction Hose, Including Strainer

Flow Rate (gpm)	Suction Hose Size (in.)											
	1½		2		2½		3		4		4½	
	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg
10	0.5	0.44										
25	1.8	1.59										
15	0.74	0.65	0.5	0.44								
40	4.1	3.6	1.0	0.9								
30	2.7	2.38	0.75	0.66								
70	11.8	10.42	4.0	3.5								
40	4.1	3.6	1.0	0.9								
70	11.8	10.42	4.0	3.5								
50			1.7	1.50	0.5	0.44						
100			6.2	5.47	2.0	1.77						
50			1.7	1.50	0.5	0.44						
150			9.3	8.21	3.0	2.7						
55			1.9	1.68	0.56	0.49						
110			6.8	6.0	2.2	1.94						
70			4.0	3.5	0.75	0.66						
135			9.8	8.65	3.6	3.18						
100					2.0	1.77	1.6	1.41				
200					8.0	7.06	3.3	2.91				
100					2.0	1.77	1.0	0.88				
225					11.7	10.33	4.7	4.15				
150					3.0	2.7	1.5	1.3				
220					11.4	10.06	4.6	4.06				
150					3.0	2.7	1.5	1.3				
250					13.0	11.47	5.2	4.59				
200									0.8	0.71	0.58	0.51
400									3.2	2.82	2.3	2.03
200									0.8	0.71	0.58	0.51
500									5.0	4.4	3.6	3.2
250									1.3	1.1	0.9	0.8
500									5.0	4.4	3.6	3.2

9.3.4 An automatic method shall be provided to prevent the loss of vacuum through the priming system when the priming device is not being operated.

9.3.4.1 A manual method shall be provided to shut off the priming system to prevent loss of vacuum (preventing back-flow) and outflow when the priming device is not in use.

9.3.4.2 If the automatic method to shut off the priming system prevents flow in both directions, a separate manual method shall not be required.

9.3.4.3 The method used to shut off the priming device shall be permitted to be a separate device integrated into the primary control.

9.4* Construction Requirements.

9.4.1* Suitable means shall be provided to completely drain the pump and all lines and accessories in cold weather, or to fill the pump and all lines with antifreeze.

9.4.2 Hydrostatic Test.

9.4.2.1 The pump body shall be subjected to a hydrostatic test pressure of 100 psi (700 kPa) above the maximum close-off pressure or to a gauge pressure of 300 psi (2000 kPa), whichever is higher, for 10 minutes.

9.4.2.2 The pump manufacturer shall provide a certificate of completion for the hydrostatic test.

9.4.3* Wetted moving parts shall be constructed of a corrosion-resistant material.

9.4.4 Where an auxiliary pump is provided in combination with a water pump and where the pumps are interconnected so that pressure from one pump can be transmitted to the other pump, check valves, intake or discharge relief valves, pump drive gear ratios, or other automatic means shall be provided to avoid pressurizing either pump beyond the hydrostatic pressure referenced in 9.4.2.1.

Table 9.2(c) Friction and Entrance Loss in 6 m of Suction Hose, Including Strainer

Flow Rate (L/min)	Suction Hose Size (mm)											
	38		51		65		75		100		110	
	m water	kPa	m water	kPa	m water	kPa	m water	kPa	m water	kPa	m water	kPa
38	0.15	1.5										
95	0.55	5.4										
56	0.23	2.2	0.15	1.5								
150	1.25	12.3	0.30	3.0								
115	0.82	8.1	0.23	2.2								
265	3.60	35.3	1.22	12.0								
150	1.25	12.3	0.30	3.0								
265	3.60	35.3	1.22	12.0								
190			0.52	5.1	0.15	1.5						
375			1.89	18.5	0.61	6.0						
190			0.52	5.1	0.15	1.5						
568			2.83	27.8	0.91	9.0						
208			0.58	5.7	0.17	1.7						
416			2.07	20.3	0.67	6.6						
265			1.22	12.0	0.23	2.2						
510			2.99	29.3	1.10	10.8						
375					0.61	6.0	0.49	4.8				
750					2.44	23.9	1.01	9.9				
375					0.61	6.0	0.15	3.0				
850					3.57	35.0	1.43	14.0				
568					0.91	9.0	0.46	4.5				
832					3.47	34.1	1.40	13.7				
568					0.91	9.0	0.46	4.5				
950					3.96	38.9	1.58	15.5				
750									0.24	2.4	0.18	1.7
1520									0.98	9.6	0.70	6.9
750									0.24	2.4	0.18	1.7
1900									1.5	14.9	1.1	10.8
950									0.4	3.7	0.27	2.7
1900									1.5	14.9	1.1	10.8

9.4.5 The entire discharge and intake piping system, valves, drain cocks and lines, and 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 capable of withstanding the same hydrostatic pressure as required in 9.4.2.1 for the pump.

9.4.6 Pump intake plumbing shall be capable of withstanding a minimum vacuum of 17 in. Hg (57.4 kPa) without deforming.

9.5 Pump Intake.

9.5.1* Intakes of the same or larger size as specified in Table 9.2(a) for suction hose size shall be provided.

9.5.1.1* Any intake 1½ in. (38 mm) or larger shall have National Hose Thread (NH).

9.5.1.2 The intake shall have a male thread unless specified otherwise.

9.5.1.3 If the couplings on the suction hose carried on the fire apparatus are of a different size from the pump intake(s)

or have means of hose attachment other than that provided on the intake(s), an adapter(s) shall be provided to allow connection of the suction hose to the pump intake(s).

9.5.2 Any 3 in. (76 mm) or larger intake valve except the tank-to-pump valve shall be a slow operating valve.

9.5.3 Each intake shall be provided with piping and a suitable closure that is capable of withstanding 100 psi (690 kPa) over the maximum pump close-off pressure or 300 psi (2070 kPa) gauge pressure, whichever is higher.

9.5.4 Any 2½ in. (65 mm) or larger intake that is located more than 42 in. (1070 mm) above the ground and to which a hose is to be connected shall be equipped with a sweep elbow of at least 30 degrees downward.

9.5.5* Each 2½ in. (65 mm) or larger valved intake shall be equipped with a bleeder valve to bleed off air or water from a hose connected to the intake.

9.5.5.1 The bleeder valve shall be operational without the operator having to get under the apparatus.

9.5.5.2 If a valved appliance is attached to an intake, it shall be equipped with a bleeder valve on each intake.

9.5.6 Intake Closures.

9.5.6.1 Intakes having male threads shall be equipped with caps; intakes having female threads shall be equipped with plugs.

9.5.6.2 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.

9.5.6.3 Caps or closures for 3½ in. (90 mm) and smaller intakes shall be removable from the intakes but remain secured to the apparatus or pumping unit.

9.5.7 Intake Strainer.

9.5.7.1 Each intake shall have a removable or accessible strainer inside the connection.

9.5.7.2* The strainer(s) shall restrict spherical debris that is too large to pass through the pump.

9.6 Pump Discharge Outlets.

9.6.1* Sufficient discharge outlets, including any discharge outlets located in hose storage areas, shall be provided to discharge the rated capacity of the pump at the flow rates as shown in Table 9.6.1.

Table 9.6.1 Flow Rates for Various Outlet Sizes

Outlet Size		Flow Rates	
in.	mm	gpm	L/min
1	25	50	200
1½	38	125	500
2½	65	250	1000

9.6.2 Each 1½ in. (38 mm) or larger discharge outlet shall be equipped with male National Hose Thread (NH).

9.6.2.1 Adapter couplings with special threads or other means for hose attachment shall be permitted to be furnished on any or all outlets.

9.6.3 Each discharge outlet, except an outlet to which a hose is to be preconnected, shall be equipped with a suitable cap or closure that is capable of withstanding 100 psi (700 kPa) over the maximum rated pump close-off pressure or 300 psi (2000 kPa) gauge pressure, whichever is higher.

9.6.3.1 Where an adapter is provided on a discharge outlet, the closures shall fit on the adapter.

9.6.3.2 If a cap or closure is provided, it shall be secured to the pumping unit with a suitable chain or cable.

9.6.4* Each discharge outlet shall be equipped with a valve that can be opened and closed smoothly at the flows shown in Table 9.6.1 at pump discharge gauge pressures of 250 psi (1700 kPa).

9.6.4.1 The flow-regulating element of each valve shall not change its position under any condition of operation that involves 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 shall be permitted to be manually or automatically controlled.

9.6.4.2* Any 3 in. (76 mm) or larger discharge valve shall be a slow operating valve.

9.6.5 Any 2½ in. (65 mm) or larger discharge outlet that is located more than 42 in. (1070 mm) above the ground and to which a hose is to be connected, but which is not in a hose storage area, shall be equipped with a sweep elbow of at least 30 degrees downward.

9.6.6* An automatic 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.

9.6.6.1 A check valve shall be included to facilitate priming.

9.6.6.2 Where a foam proportioning system is provided, this line shall be plumbed so the water returning to the water tank is free of foam solution.

9.6.7 If the apparatus is equipped with a booster reel, the piping, valves, and swivel between the pump and booster reel shall be nominally the same size or larger than the nominal inside diameter of the hose to be carried on the reel.

9.6.7.1 A shutoff valve shall be provided between the pump and the reel.

9.6.7.2 High-pressure booster hose of the same nominal size shall be permitted in place of piping.

9.6.8 All discharge valves 1 in. (25 mm) or over in size shall be quarter-turn types.

9.6.9 Where the valve operating mechanism does not indicate the position of the valve, an indicator shall be provided to show when the valve is open.

9.6.10 Visible quarter-turn valves shall be installed so they are open when the handle is parallel with the run of the pipe and are closed when the handle is perpendicular to the run of the pipe.

9.6.11 Blind valves (valves behind panels) shall have their open and closed positions marked — “Open” and “Closed.”

9.6.12* When a foam proportioning system is installed, a water-only (no foam) discharge shall be installed.

9.6.13 Operating mechanisms for valves used on the fire-ground shall be marked as to their function, such as “Intake,” “Tank to Pump,” “Pump to Tank,” and “Discharge.”

9.7 Pump Operator's Position.

9.7.1 The pump controls, gauges, and instruments shall be accessed from ground level, a working platform, or a driver's compartment.

9.7.2 All gauges, discharge outlets, pump intakes, and controls shall be illuminated to a minimum lighting level of 5 fc (50 lx).

9.7.3 The control for the priming system shall be capable of being operated by the person operating the controls at the primary pump operator's position.

9.8 Gauges and Instruments.

9.8.1 A master pump compound gauge shall be provided that is visible at the pump operator's position.

9.8.1.1 If an analog gauge is used, it shall meet the following requirements:

- (1) The numerals shall be a minimum of ¼ in. (6.4 mm) high.
- (2) There shall be graduation lines showing at least every 10 psi (70 kPa), with major and intermediate graduation lines emphasized and figures at least every 100 psi (700 kPa).
- (3) The accuracy of the gauge shall be a minimum of Grade B as defined in ASME B40.100, *Pressure Gauges and Gauge Attachments*.

9.8.1.2 If a digital gauge is used, it shall meet the following requirements:

- (1) The digits shall be at least ½ in. (12.7 mm) high.
- (2) The gauge shall display pressure in increments of not more than 10 psi (70 kPa).
- (3) The gauge shall have an accuracy of ±3 percent over the full scale.

9.8.1.3 The gauge shall read from 30 in. Hg (100 kPa) vacuum to at least 100 psi (700 kPa) higher than the maximum pump close-off pressure.

9.8.1.4 The pressure gauge shall be connected directly at the pump discharge, before any check valves.

9.8.2* If the pump on the apparatus is driven by the chassis engine through a PTO, and the apparatus is designed for pump-and-roll operations using that chassis engine-driven pump, a second gauge that meets the same requirements as the compound gauge required by 9.8.1 shall be mounted in the driving compartment in view of the driver.

9.8.3 If one or more 2½ in. (65 mm) or larger external pump intakes are provided, a pump intake gauge shall be provided.

9.8.3.1 If an analog gauge is used, it shall meet the following requirements:

- (1) The numerals shall be a minimum of ¼ in. (6.4 mm) high.
- (2) There shall be graduation lines showing at least every 10 psi (70 kPa), with major and intermediate graduation lines emphasized and figures at least every 100 psi (700 kPa).
- (3) The accuracy of the gauge shall be a minimum of Grade B as defined in ASME B40.100.

9.8.3.2 If a digital gauge is used, it shall meet the following requirements:

- (1) The digits shall be at least ½ in. (12.7 mm) high.
- (2) The gauge shall display pressure in increments of not more than 10 psi (70 kPa).
- (3) The gauge shall have an accuracy of ±3 percent over the full scale.

9.8.3.3 The gauge shall read from 30 in. Hg (100 kPa) vacuum to at least 300 psi (2000 kPa).

9.8.4 If both an intake gauge and a master discharge gauge are provided, a label at the intake gauge shall read “Pump Intake” and a label at the master discharge gauge shall read “Pump Discharge.”

9.8.5 Each pressure gauge or flowmeter, and its respective display, shall be mounted and attached so it is protected from accidental damage and excessive vibration.

9.9* Pump Controls.

9.9.1 General Provisions. Provisions shall be made for placing the pump drive system in operation using controls and switches that are identified and within convenient reach of the operator.

9.9.1.1 Where the pump is driven by the chassis engine, and engine compression brakes or engine exhaust brakes are furnished, these engine brakes shall be automatically disengaged for pumping operations.

9.9.1.2* Any control device used in the pumping system power train between the engine and the pump, except a manual pump shift override device if provided, shall be equipped with a means to prevent unintentional movement of the control device from its set position in the pumping mode.

9.9.1.3 A label 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 read from the driver’s position.

9.9.1.4 Where the pump is driven by the chassis engine and transmission through a split shaft PTO, the driving compartment speedometer shall register when the pump drive system is engaged.

9.9.1.5 Where chassis transmission retarders are furnished, they shall be automatically disengaged for pumping operations.

9.9.2 Stationary Pump Driven Through Split Shaft PTO — Automatic Chassis Transmission. Where the apparatus is equipped with an automatic chassis transmission, the water pump is driven by the chassis engine through the transmission’s main driveline, and the apparatus is to be used for stationary pumping only, an interlock system shall be provided to ensure that the pump drive system components are engaged in the pumping mode of operation so that the pumping system can be operated from the pump operator’s position.

9.9.2.1* A “Pump Engaged” indicator shall be provided in the driving compartment to indicate that the pump shift process has been successfully completed.

9.9.2.2 An “OK to Pump” indicator shall be provided in the driving compartment to indicate that the pump is engaged, the chassis transmission is in pump gear, and the parking brake is engaged.

9.9.2.3 A “Throttle Ready” indicator shall be provided at the pump operator’s panel to indicate that the apparatus is in “OK to Pump” mode or that the chassis transmission is in neutral and the parking brake is engaged.

9.9.3 Stationary Pump Driven Through Split Shaft PTO — Manual Chassis Transmission. Where the apparatus is equipped with a manual chassis transmission, the water pump is driven by the chassis engine through the transmission’s main driveline, and the apparatus is to be used for stationary pumping only, an interlock system shall be provided to ensure that the pump drive system components are engaged in the pumping mode of operation so that the pumping system can be operated from the pump operator’s position.

9.9.3.1* A “Pump Engaged” indicator shall be provided in the driving compartment to indicate that the pump shift has been successfully completed.

9.9.3.2 An “OK to Pump” indicator shall be provided in the driving compartment to indicate that the pump is engaged and the parking brake is engaged.

9.9.3.3 A “Throttle Ready” indicator shall be provided at the pump operator’s panel to indicate that the apparatus is in “OK to Pump” mode or that the parking brake is engaged.