

NFPA® 1911

Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus

2012 Edition



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An International Codes and Standards Organization



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NFPA® 1911

Standard for the

Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus

2012 Edition

This edition of NFPA 1911, *Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus*, was prepared by the Technical Committee on Fire Department Apparatus. It was issued by the Standards Council on December 13, 2011, with an effective date of January 2, 2012, and supersedes all previous editions.

This edition of NFPA 1911 was approved as an American National Standard on January 2, 2012.

Origin and Development of NFPA 1911

The 2007 edition of NFPA 1911, *Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus*, combined three standards into a single document: NFPA 1911, *Standard for Service Tests of Fire Pump Systems on Fire Apparatus*; NFPA 1914, *Standard for Testing Fire Department Aerial Devices*; and NFPA 1915, *Standard for Fire Apparatus Preventive Maintenance Program*. A chapter was added on the retirement of fire apparatus. The out-of-service criteria in NFPA 1915 were reevaluated to define some conditions that require a fire apparatus to be taken out of service immediately and some conditions that a technician needs to evaluate on a case-by-case basis to determine if the apparatus is safe for continued use. The term *service test* was changed to *performance test*, and new testing requirements were added for the apparatus chassis, low-voltage electrical system, foam proportioning system, compressed air-foam system, line voltage electrical system, and breathing air-compressor system.

The 2012 edition of this standard is a general update and review of the document with minor editorial clarifications.

History of NFPA 1911

The first edition of NFPA 1911 was issued in 1987 and was titled *Standard on Acceptance and Service Tests of Fire Department Pumping Apparatus*. It incorporated much of the material formerly included in the pamphlet *Fire Department Pumper Tests and Fire Stream Tables*, published by the National Board of Fire Underwriters and later by the Insurance Services Office.

In 1991, the requirements for the testing of fire pumps on new fire apparatus were transferred to the standards for new fire apparatus. Material previously referenced from other documents was added to make this document self-contained. The requirements were changed to include pumps of 250 gpm (1000 L/min) and larger capacity rated at 150 psi (1000 kPa).

The 1997 edition expanded the tables to include data for pumps to 3000 gpm (12,000 L/min), added accuracy requirements for flow and speed measuring equipment, and required a tank-to-pump flow-rate check. The name of the standard was changed to *Standard for Service Tests of Fire Pump Systems on Fire Apparatus* to reflect that components of the pumping system, such as the tank-to-pump piping, were being checked.

The 2002 edition added requirements for testing the priming device, the intake relief valve system, and, for pumps rated at 750 gpm (3000 L/min) or more, the pumping engine overload capability.

History of NFPA 1914

The first edition of NFPA 1914 dates to 1954, when the Fire Department Equipment Committee presented a document titled *Standard Procedure for Aerial Ladder Testing*, which was designated as NFPA 193 for tentative adoption. In 1955, it received final adoption. The document contained separate tests for wood and metal aerial ladders.

In 1958, material covering the use, maintenance, and testing of in-service ground ladders was added to the document, and a single procedure for testing both wood and metal aerial ladders was approved. The 1959 edition added requirements for new aluminum ground ladders for fire department use. The 1972 edition introduced tests for evaluating platforms.

In 1975, NFPA 193 was separated into two documents, one for aerial ladders and the other for ground ladders. The new *Recommended Practice for the Maintenance, Care, Testing, and Use of Fire Department Aerial Ladders and Elevating Platforms* was designated as NFPA 1904. The ground ladders were covered in NFPA 1931, *Standard on Fire Department Ground Ladders*.

A complete revision in 1980 changed the document to a standard and renamed it *Standard for Testing Fire Department Aerial Ladders and Elevating Platforms*. In 1988, more details on required inspections were included and requirements for nondestructive testing of critical components and the testing of water towers were added. The document was renumbered and renamed NFPA 1914, *Standard for Testing Fire Department Aerial Devices*.

The 1991 edition added clarification to the acceptance criteria for weld and other nondestructive testing inspections, revised the requirements for water system tests, and included required testing of additional components of the aerial devices. The 1997 edition added text to provide repair recommendations when the manufacturer is no longer in business, required that free weights be used in testing, allowed for acoustic emission testing, added requirements for testing secondary operating controls, and added a suggested form for recording the inspection and test results.

The 2002 edition revised the qualifications for testing personnel, added additional requirements for the inspection and testing of tractor-drawn components, and more clearly delineated when nondestructive testing is required in addition to the inspections, operational tests, and load tests.

History of NFPA 1915

The National Transportation Safety Board (NTSB) report “Special Investigation Report—Emergency Fire Apparatus,” adopted March 19, 1991, raised concerns about the quality and type of service and repair being done on fire apparatus. Subsequent inquiries from the Federal Department of Transportation (DOT) about the different types, uses, and weights of apparatus and how they are maintained prompted the International Association of Fire Chiefs (IAFC) Apparatus Maintenance Section to petition NFPA to write a preventive maintenance standard for fire apparatus. While NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, requires fire departments to establish a preventive maintenance program for their apparatus and equipment, there was no standard for such a program.

The first edition of NFPA 1915, *Standard for Fire Apparatus Preventive Maintenance Program*, was issued in 2000 to establish the minimum requirements for a preventive maintenance program for fire apparatus. These requirements were designed to improve the safety and reliability of fire apparatus and support the requirements in other NFPA standards related to emergency vehicle maintenance programs.



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

Chapter 1 Administration**1.1 Scope.**

1.1.1 This standard defines the minimum requirements for establishing an inspection, maintenance, and testing program for in-service fire apparatus.

1.1.2 This standard includes guidelines for fire apparatus refurbishment and retirement.

1.1.3 This standard identifies the systems and items on a fire apparatus that are to be inspected and maintained, the frequency of such inspections and maintenance, and the requirements and procedures for conducting performance tests on components.

1.1.4 This standard provides sample forms for collecting inspection and test data.

1.2 Purpose.

1.2.1 The primary purpose of this standard is to provide requirements for an inspection, maintenance, and testing program

that will ensure that in-service fire apparatus are serviced and maintained to keep them in safe operating condition and ready for response at all times.

1.2.2 The secondary purpose of this standard is to establish that safety is a primary concern for the continued in-service use of a fire apparatus and the ultimate decision to refurbish or retire that fire apparatus.

1.2.3 It is not the intent of this standard to restrict any jurisdiction from exceeding the minimum requirements described in this document.

1.3 Application.

1.3.1 This standard shall apply to public or private organizations utilizing fire apparatus.

1.3.2 This standard shall apply to all in-service fire apparatus, regardless of the year of manufacture.

1.3.3 This standard shall apply to permanently installed components on fire apparatus.

1.3.4 This standard shall not apply to portable equipment carried on fire apparatus unless otherwise stated in specific requirements.

1.3.5 The provisions of this standard shall not supersede any instructions, specifications, or practices defined or required by the fire apparatus manufacturer, component manufacturer, equipment manufacturer, or authority having jurisdiction.

1.4 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.

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

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

1.5* Units and Formulas.

1.5.1 In this standard, values for measurement in inch-pound units are followed by an equivalent in metric units.

1.5.2 Either set of values shall be permitted to be used, but the same set of values (either inch-pound units or metric 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 1071, *Standard for Emergency Vehicle Technician Professional Qualifications*, 2011 edition.

NFPA 1901, *Standard for Automotive Fire Apparatus*, 2009 edition.

NFPA 1989, *Standard on Breathing Air Quality for Emergency Services Respiratory Protection*, 2008 edition.

2.3 Other Publications.

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

ASME B40.100, *Pressure Gauges and Gauge Attachments*, 2005.

2.3.2 ASNT Publications. American Society for Nondestructive Testing, Inc., 1711 Arlingate Lane, Columbus, OH 43228-0518.

ASNT CP-189, *Standard for Qualification and Certification of Nondestructive Testing Personnel*, 2001.

2.3.3 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM B 647, *Standard Test Method for Indentation Hardness of Aluminum Alloys by Means of a Webster Hardness Gage*, 1984 (reconfirmed 2006).

ASTM B 648, *Standard Test Method for Indentation Hardness of Aluminum Alloys by Means of a Barcol Impressor*, 1978 (reconfirmed 2006).

ASTM E 6, *Standard Terminology Relating to Methods of Mechanical Testing*, 2006.

ASTM E 10, *Standard Test Method for Brinell Hardness of Metallic Materials*, 2001.

ASTM E 18, *Standard Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials*, 2005.

ASTM E 92, *Standard Test Method for Vickers Hardness of Metallic Materials*, 1982 (reconfirmed 2003).

ASTM E 114, *Standard Practice for Ultrasonic Pulse-Echo Straight-Beam Examination by the Contact Method*, 1995 (reconfirmed 2005).

ASTM E 165, *Standard Test Method for Liquid Penetrant Examination*, 2002.

ASTM E 569, *Standard Practice for Acoustic Emission Monitoring of Structures During Controlled Stimulation*, 2002.

ASTM E 650, *Standard Guide for Mounting Piezoelectric Acoustic Emission Sensors*, 1997 (reconfirmed 2002).

ASTM E 709, *Standard Guide for Magnetic Particle Examination*, 2001.

ASTM E 797, *Standard Practice for Measuring Thickness by Manual Ultrasonic Pulse-Echo Contact Method*, 2005.

ASTM E 1004, *Standard Practice for Determining Electrical Conductivity Using the Electromagnetic (Eddy-Current) Method*, 2002.

ASTM E 1220, *Standard Test Method for Visible Penetrant Examination Using the Solvent-Removable Process*, 2005.

ASTM E 1316, *Standard Terminology for Nondestructive Testing*, 2006.

ASTM E 1418, *Standard Test Method for Visible Penetrant Examination Using the Water-Washable Process*, 2005.

2.3.4 AWS Publications. American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

AWS B1.10, *Guide for the Nondestructive Examination of Welds*, 1999.

AWS D1.1, *Structural Welding Code — Steel*, 2005.

AWS D1.2, *Structural Welding Code — Aluminum*, 2003.

2.3.5 ISO Publications. International Organization for Standardization, 1 rue de Varembé, Case postale 56, CH-1211 Genève 20, Switzerland.

ISO/IEC 17020, *General criteria for the operation of various types of bodies performing inspection*, 1998.

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

SAE J959, *Lifting Crane, Wire-Rope Strength Factors*, 1991.

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

Title 49, Code of Federal Regulations, Part 399.211, Appendix G, “Minimum Periodic Inspection Standards,” 1988.

2.3.8 Other Publications.

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

2.4 References for Extracts in Mandatory Sections.

NFPA 70®, *National Electrical Code*®, 2011 edition.

NFPA 99, *Health Care Facilities Code*, 2012 edition.

NFPA 414, *Standard for Aircraft Rescue and Fire-Fighting Vehicles*, 2012 edition.

NFPA 1451, *Standard for a Fire Service Vehicle Operations Training Program*, 2007 edition.

NFPA 1901, *Standard for Automotive Fire Apparatus*, 2009 edition.

NFPA 1912, *Standard for Fire Apparatus Refurbishing*, 2011 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 Acoustic Emission Inspection. A method of nondestructive testing (NDT) that utilizes acoustic or sound waves.

3.3.2 Adjust. To maintain or regulate, within prescribed limits, by setting the operating characteristics to specified parameters.

3.3.3 Aerial Device. An aerial ladder, elevating platform, or water tower that is designed to position personnel, handle materials, provide continuous egress, or discharge water. [1901, 2009]



3.3.4 Aerial Ladder. A self-supporting, turntable-mounted, power-operated ladder of two or more sections permanently attached to a self-propelled automotive fire apparatus and designed to provide a continuous egress route from an elevated position to the ground. [1901, 2009]

3.3.5 Aerial Ladder Sections. The structural members of the aerial ladder consisting of the base and fly sections.

3.3.6 Alignment. To adjust components to bring about optimum or desired performance.

3.3.7 Ambient Temperature. The temperature of the surrounding medium; usually used to refer to the temperature of the air in which a structure is situated or a device operates. [414, 2012]

3.3.8 American Society for Nondestructive Testing (ASNT). A professional organization that is devoted to promoting knowledge of nondestructive testing.

3.3.9 American Welding Society (AWS). An association that provides codes, guidelines, and standards utilized to evaluate welded structures and components in welded structures.

3.3.10 Ancillary Boom Ladder. A ladder or ladders affixed to a telescoping or articulating boom section.

3.3.11 Articulating Boom. An aerial device consisting of two or more folding boom sections whose extension and retraction modes are accomplished by adjusting the angle of the knuckle joints. [1901, 2009]

3.3.12 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, 2009]

3.3.13 Auxiliary Hydraulic Power. A small gasoline engine, diesel engine, or electric motor-driven hydraulic pump used to operate an aerial device in an emergency or in lieu of the main hydraulic system. [1901, 2009]

3.3.14* Auxiliary Pump. A water pump mounted on the fire apparatus that is used for fire-fighting operations that is neither a fire pump, an industrial supply pump, nor a transfer pump.

3.3.15 Base Rail. The lower chord (rail) of an aerial ladder to which rungs and reinforcements are attached. [1901, 2009]

3.3.16 Base Section. The first or bottom section of an aerial device. [1901, 2009]

3.3.17 Boom. An assembled section of an aerial device. The boom construction can be of the stressed-skin box beam type, the trussed lattice type, or the open "U" truss-type design. [1901, 2009]

3.3.18 Boom Boost Cylinders. The hydraulic cylinders located on the upper boom of an articulating boom aerial device that help lift the upper boom from the lower boom.

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

3.3.20 Bow. The distance that the end of an aerial ladder or boom deviates from a straight line extension of the base section.

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

3.3.22 Cable Separation Guide. The mechanism that aligns and separates the cable when it is wound on the drum of an aerial ladder's extension winch.

3.3.23 Calibrate. To correlate the reading of an instrument or system of measurement with a standard.

3.3.24 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, 2009]

3.3.25 Collector Rings. An assembly of slip rings for transferring electrical energy from a stationary to a rotating member. [70:675.2]

3.3.26 Combination Vehicle. A vehicle consisting of a towing vehicle and one or more towed units.

3.3.27 Component. A constituent part of a mechanical or electrical device.

3.3.28* Compound Gauge. A gauge that indicates pressure both above and below atmospheric pressure.

3.3.29 Cylinder Links. The mechanisms that can be used in connecting an articulating boom to the end of the upper elevating cylinders or to the lower and upper booms.

3.3.30 Deficiency(ies). A discontinuity in a part or a failure to function that interferes with the service or reliability for which the part was intended.

3.3.31 Deflection. The deviation from a straight course or fixed direction.

3.3.32 Deformation. Abnormal wear, defects, cracks or fractures, warpage, and deviations from the original condition that would affect safe and correct operation.

3.3.33 Diagnostic Check. An in-depth operational analysis of a system or component to verify that it is operating correctly.

3.3.34 Discharge Pressure. The water pressure on the discharge manifold of the fire pump at the point of gauge attachment.

3.3.35 Discontinuity. A change in the normal, physical structure of a material that can affect its serviceability.

3.3.36 Diverter Valve. A valve that, when actuated, diverts hydraulic fluid from one function to another or from one hydraulic system to another; in aerial devices, it is the valve that diverts hydraulic fluid from the hydraulic system for the stabilizers to the hydraulic system for the aerial device when the aerial device is in use and from the hydraulic system for the aerial device to the hydraulic system for the stabilizers when they are being deployed or stowed.

3.3.37 Documentation. Any written or electronic data or information relative to the apparatus, including information on its operational checks, diagnostic checks, inspection, maintenance, and performance testing.

3.3.38 Draft. The use of suction to move a liquid (such as water) from a vessel or source that is below the intake of a pump.

3.3.39 Drift. A time-dependent movement away from an established position.

3.3.40 Drivetrain. The parts of a fire apparatus that transmit power from the engine to the wheels, including the transmission, split shaft power takeoff, midship pump transmission, drive shaft(s), clutch, differential(s), and axles.

3.3.41* Electronic Battery Conductance Tester. A type of battery tester that uses proprietary electronic circuitry to determine the condition, or state of health (SOH), of a vehicle battery and does not apply a resistive load during the test.

3.3.42 Elevating Platform. A self-supporting, turntable-mounted device consisting of a personnel-carrying platform attached to the uppermost boom of a series of power-operated booms that articulate, telescope, or both and that are sometimes arranged to provide the continuous egress capabilities of an aerial ladder. [1901, 2009]

3.3.43 Elevation Cylinder. The hydraulic components consisting of a cylinder barrel, cylinder rod, and related hardware that are used to vary the angle of the ladder or booms.

3.3.44 Elevation Indicator. An instrument on an aerial device that shows the angle of elevation of the aerial ladder or boom.

3.3.45 Elevation Lock. A manual- or positive-locking device (i.e., holding valve) that can be actuated to maintain indefinitely a desired angle or elevation without dependence upon engine power.

3.3.46 Emergency Hand-Crank Control. An auxiliary or supplemental control with which the operator can manually operate select functions of the aerial device.

3.3.47 Extension Cylinder. The hydraulic components consisting of a cylinder barrel, cylinder rod, and related hardware that are used to vary the length of extension of a telescoping aerial device.

3.3.48 Extension Indicator. A device on an aerial ladder or extensible boom aerial device that indicates the number of feet (meters) that the device has been extended.

3.3.49 Extension Sheave. A pulley through which an extension cable operates.

3.3.50 Failure. A cessation of proper functioning or performance.

3.3.51 Fastener. A mechanical device, such as a rivet, bolt, screw, or pin, that is used to hold two or more components together securely.

3.3.52 Ferromagnetic Materials. Materials, such as iron, cobalt, and nickel, that have an abnormally high magnetic permeability.

3.3.53 Fire Apparatus. A vehicle designed to be used under emergency conditions to transport personnel and equipment, and to support the suppression of fires and mitigation of other hazardous situations. [1901, 2009]

3.3.54 Fire Pump. A water pump with a rated capacity of 250 gpm (1000 L/min) or greater at 150 psi (1000 kPa) net pump pressure that is mounted on a fire apparatus and used for fire fighting. [1901, 2009]

3.3.55 Fly Locks. See 3.3.71, Ladder Locks.

3.3.56 Fly Section. Any section of an aerial telescoping device beyond the base section. [1901, 2009]

3.3.57 Fracture. A type of defect found in welds that has a large length-to-width ratio and travels through or adjacent to

the metal grain boundaries; usually, this type of defect is referred to as a crack.

3.3.58 Frame. The basic structural system that transfers the weight of the fire apparatus to the suspension system.

3.3.59 Gauge. A visual device that indicates a measurement.

3.3.60 Gauge Pressure. Pressure measured by an instrument where the pressure indicated is relative to atmospheric pressure.

3.3.61 Hinge Pins. Pins that are used at either the swivel or point of articulation of an aerial device.

3.3.62 Holding Valve. A valve that maintains hydraulic pressure in a hydraulic actuator (cylinder, motor, etc.) until it is activated to release.

3.3.63 In-Service Fire Apparatus. Any fire apparatus, including reserve apparatus, that is available for use under emergency conditions to transport personnel and equipment and to support suppression of fires and mitigation of other hazardous conditions.

3.3.64 Inspect(ion). To determine the condition or operation of a component(s) by comparing its physical, mechanical, and/or electrical characteristics with established standards, recommendations, and requirements through examination by sight, sound, or feel.

3.3.65* Instability. A condition of a mobile unit in which the sum of the moments tending to overturn the unit exceeds the sum of the moments tending to resist overturning. [1901, 2009]

3.3.66 Intake Pressure. The pressure on the intake passage-way of the pump at the point of gauge attachment.

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

3.3.68 Ironing. Damage in the form of wear or indentations caused to the bottom of the aerial device base rail material by misalignment or malfunction of the rollers or slides.

3.3.69 Knuckle. A point of connection between upper and lower booms of an articulating device; the point at which lower and upper booms are hinged together. [1901, 2009]

3.3.70 Ladder Cradle. A structural component that supports an aerial ladder when it is bedded.

3.3.71 Ladder Locks. The mechanical locks or pawls that prevent movement of the sections of an aerial device when the power is shut off or in the event of loss of pressure in hydraulic circuits.

3.3.72 Leak. The escape of a gas or liquid from a hose, pipe, coupling, connection, or other confining structure at any point where the escape should not occur.

3.3.73 Leakage. The escape of a fluid from its intended containment, generally at a connection.

3.3.73.1 Class 1 Liquid Leakage. Seepage of liquid, as indicated by wetness or discoloration, not great enough to form drops.

3.3.73.2 Class 2 Liquid Leakage. Leakage of liquid great enough to form drops, but not enough to cause drops to fall from the item being inspected.

3.3.73.3 Class 3 Liquid Leakage. Leakage of liquid great enough to cause drops to fall from the item being inspected.

3.3.74 Leveling Linkages. The components and controls for achieving a level position of the platform.

3.3.75 Lift. The vertical height that water must be raised during a drafting operation, measured from the surface of a static source of water to the centerline of the pump intake.

3.3.76 Liquid Penetrant Inspection. A nondestructive inspection method used to locate and determine the severity of surface discontinuities in materials, based on the ability of a liquid to penetrate into small openings, such as cracks.

3.3.77 Load Limit Indicator. A load indicator or an instruction plate, visible at the operator's position, that shows the recommended safe load at any condition of an aerial device's elevation and extension. [1901, 2009]

3.3.78 Magnetic Particle Inspection. A nondestructive inspection method used to locate discontinuities in ferromagnetic materials by magnetizing the material and then applying an iron powder to mark and interpret the patterns that form.

3.3.79 Maintenance. The act of servicing a fire apparatus or a component in order to keep the vehicle and its components in proper operating condition.

3.3.80 Manufacturer's Recommendation (Specification). Any requirement or suggestion a fire apparatus builder or component producer makes in regard to care and maintenance of its product(s).

3.3.81 Modification. An alteration or adjustment to any component that is a deviation from the original specifications or design of the fire apparatus.

3.3.82 Negative Pressure. Pressure less than atmospheric. [99, 2012]

3.3.83* 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, 2009]

3.3.84 Neutral Position. The position of operating controls when the controls are not engaged.

3.3.85 Nondestructive Testing (NDT). One of several methods used to inspect a structural component without physically altering or damaging the materials.

3.3.86 Operational Check. To determine the operational readiness of a component on a fire apparatus by observing the actual operation of the component.

3.3.87 Operator. A person qualified to operate a fire apparatus. [1912, 2011]

3.3.88 Operator Alert Device. Any device, whether visual, audible, or both, installed in the driving compartment or at an operator's panel, to alert the operator to either a pending failure, an occurring failure, or a situation that requires his or her immediate attention.

3.3.89* Optical Source. Any single, independently mounted, light-emitting component in a lighting system. [1901, 2009]

3.3.90 Out-of-Service. The condition when an apparatus or component is not usable due to an unsafe or inoperable condition.

3.3.91 Overhaul (Rebuild). To make extensive repairs in order to restore a component to like-new condition in accordance with the original manufacturer's specifications.

3.3.92 Override. A system or device used to neutralize a given action or motion. [1901, 2009]

3.3.93 Performance Tests. Tests made after a fire apparatus has been put into service to determine if its performance meets predetermined specifications or standards.

3.3.94 Platform. An assembly consisting of the support structure, floor, railings, and operator's secondary controls that is attached to the tip of a boom or an aerial ladder for carrying personnel and equipment.

3.3.95 Pneumatic Lines. The lines that supply air, which is normally for a breathing air system or for pneumatic power tools, to a platform or to the tip of an aerial ladder.

3.3.96 Power Source. A device that produces line voltage electricity.

3.3.97 Powered Equipment Rack. A power-operated device that is intended to provide storage of hard suction hoses, ground ladders, or other equipment, generally in a location above apparatus compartments. [1901, 2009]

3.3.98 Preventive Maintenance. The act or work of keeping something in proper condition by performing necessary preventive actions in a routine manner to prevent failure or breakdown.

3.3.99 Proper(ly). In accordance with the manufacturer's specifications or as recommended by the manufacturer.

3.3.100 PTO. Power takeoff. [1901, 2009]

3.3.101 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 the subject matter, the work, or the project. [1451, 2007]

3.3.102 Rated Capacity (Aerial Device). The total amount of weight of all personnel and equipment that can be supported at the outermost rung of an aerial ladder or on the platform of an elevating platform with the aerial device placed in the horizontal position at its maximum horizontal extension when the stabilizers are fully deployed. [1901, 2009]

3.3.103 Rated Capacity (Water Pump). The flow rate to which the pump manufacturer certifies compliance of the pump when it is new. [1901, 2009]

3.3.104* Rated Vertical Height. The vertical distance measured by a plumb line from the maximum elevation of the aerial device allowed by the manufacturer to the ground.

3.3.105 Relief Valve. A device that allows the bypass of fluids to limit the pressure in a system.

3.3.106 Repair. To restore to sound condition after failure or damage.

3.3.107 Replace. To remove an unserviceable item and install a serviceable counterpart in its place.

3.3.108 Reserve Fire Apparatus. A fire apparatus retained as a backup apparatus and used to replace a primary apparatus when the primary apparatus is out of service.

3.3.109 Retired Fire Apparatus. A vehicle that was previously a fire apparatus but which, due to age or condition, is no longer capable of supporting the suppression of fires, the mitigation of hazardous situations, or operations at an emergency scene.

3.3.110 Rotation Gear. The main gear of an aerial device that is used for the rotation of the turntable.

3.3.111 Rotation Gear Reduction Box. The mechanism of an aerial device that transfers hydraulic or electric power to the rotation gear, creating the torque necessary to rotate the turntable.

3.3.112 Rotation Lock. A strong friction or other positive-locking device (e.g., holding valve) that retains the turntable in any desired position.

3.3.113 Rung Cap Casting. A casting that can be riveted to the outside of the base rail over the ends of each rung on an aerial ladder.

3.3.114 Safety Stop Mechanism. A device that is located on the aerial device and prevents raising the elevating platform booms or sections beyond safe operating horizontal or vertical angles.

3.3.115 Service Tests. See 3.3.93, Performance Tests.

3.3.116 Severe Service. Those conditions that apply to the rigorous, harsh, and unique applications of fire apparatus, including, but not limited to, local operating and driving conditions, frequency of use, and manufacturer's severe service (duty) parameters.

3.3.117 Slide Blocks. Blocks made of a variety of materials (e.g., brass, nylon) that act as spacing devices, wear strips, or wear pads.

3.3.118 Stabilizer. A device integral with or separately attached to the chassis of a fire apparatus with an aerial device that is used to increase the moments tending to resist overturning the apparatus.

3.3.119 Stabilizer Pad. A plate inserted beneath a stabilizer shoe to give greater surface bearing area. [1901, 2009]

3.3.120 Stabilizer Shoe. A permanently mounted shoe on a stabilizer to provide a ground surface area. [1901, 2009]

3.3.121 Steering Axle(s). Any axle(s) designed such that the wheels have the ability to turn the vehicle.

3.3.122 Stressed-Skin-Type Boom Section. A boom framework that is fabricated by the welding of metal into full box sections with internal torsional members.

3.3.123 Telescopic. Extended or retracted by sliding of the overlapping sections.

3.3.124 Test. To verify serviceability by measuring the mechanical, pneumatic, hydraulic, or electrical characteristics of an item and comparing those characteristics with prescribed standards.

3.3.125 Top Rail. The top chord (rail) of an aerial ladder to which reinforcements are attached. [1901, 2009]

3.3.126 Torque Box. A structural component placed between the turntable and the chassis or part of the chassis frame of an aerial device to absorb the stresses of operation.

3.3.127 Torque Value. A measure of tightness or the amount of stress that is put on a fastening device (i.e., bolt) to secure it properly.

3.3.128 Total Continuous Electrical Load. The total current required to operate all of the devices permanently connected to the apparatus that can be simultaneously energized excluding intermittent-type loads such as primers and booster reel rewind motors. [1901, 2009]

3.3.129 Transfer Pump. A water pump mounted on the apparatus that is used to transfer water to and from the fire apparatus.

3.3.130 Trussed-Lattice-Type Boom Section. An open truss boom framework with vertical and diagonal braces that are fastened to horizontal beams of the frame.

3.3.131 Twist. The degree of rotational movement from a given position.

3.3.132 Ultrasonic Inspection. A nondestructive method of inspection in which high-frequency vibrations are injected through the surface of the test material and bounced back to their source from the opposite surface; if a flaw exists, signals return in a different pattern, revealing the location and extent of the flaw.

3.3.133* Vacuum. The reduction in atmospheric pressure inside a pump or suction hose.

3.3.134 Visual Inspection. Inspection by the eye without recourse to any optical devices, except prescription eyeglasses.

3.3.135 Water Tower. An aerial device consisting of permanently mounted power-operated booms and a waterway designed to supply a large-capacity mobile elevated water stream. The booms can be of articulating design or telescoping design. [1901, 2009]

3.3.136 Weldment. A structure that is formed by the welding together of several components.

Chapter 4 General Requirements

4.1* General. All fire apparatus that could be placed in service for emergency response shall be inspected, maintained, tested, and retired as required by this standard.

4.1.1 Chassis, Driving and Crew Compartment, and Body.

4.1.1.1 The chassis, driving and crew compartment, and body shall be inspected and maintained as required by Chapter 7.

4.1.1.2 The chassis components shall be performance tested as required by Chapter 16.

4.1.2 Electrical Systems.

4.1.2.1 The low-voltage electrical systems on the fire apparatus shall be inspected and maintained as required by Chapter 8 and performance tested as required by Chapter 17.

4.1.2.2 If the apparatus is equipped with a line voltage electrical system, that system shall be inspected and maintained as required by Chapter 13 and performance tested as required by Chapter 22.

4.1.3 Water Pumping System or Water Tank.

4.1.3.1 If the fire apparatus is equipped with a water pumping system or a water tank, the water pumping system(s) or the water tank(s) shall be inspected and maintained as required by Chapter 9.

4.1.3.2 If the apparatus is equipped with a fire pump or an industrial supply pump, the fire pump system or industrial supply pump system shall be performance tested as required by Chapter 18.

4.1.4 Aerial Device. If the fire apparatus is equipped with an aerial device, the aerial device shall be inspected and maintained as required by Chapter 10 and performance tested as required by Chapter 19.



4.1.5 Foam Proportioning System. If the fire apparatus is equipped with a foam proportioning system, the system shall be inspected and maintained as required by Chapter 11 and performance tested as required by Chapter 20.

4.1.6 Compressed Air Foam System (CAFS). If the fire apparatus is equipped with a compressed air-foam system, the system shall be inspected and maintained as required by Chapter 12 and performance tested as required by Chapter 21.

4.1.7 Compressed Air Systems.

4.1.7.1 If the fire apparatus is equipped with a compressed air system, the system shall be inspected and maintained as required by Chapter 14.

4.1.7.2 If the apparatus is equipped with a breathing air system, the system shall be performance tested as required by Chapter 23.

4.1.8 Winches. If the fire apparatus is equipped with a winch, the winch shall be inspected and maintained as required by Chapter 15.

4.1.9 Other Components or Auxiliary Systems. If there are other fixed components or auxiliary systems on the fire apparatus, those components or auxiliary systems shall be inspected, maintained, and tested in accordance with the component manufacturer's recommendations and this standard to the extent that the requirements are applicable.

4.2 Taking Fire Apparatus Out of Service. It shall be the responsibility of the authority having jurisdiction (AHJ) to enforce the criteria for when the apparatus is to be taken out of service in accordance with the requirements in Chapter 6.

4.3 Qualifications of Personnel.

4.3.1 Inspections, maintenance, and testing on fire apparatus shall be performed by qualified personnel as required by 4.3.1.1, 4.3.1.2 or 4.3.1.3.

4.3.1.1* Any person performing diagnostic checks, inspections, testing, or maintenance of the fire apparatus shall meet the qualifications of NFPA 1071, *Standard for Emergency Vehicle Technician Professional Qualifications*, or the equivalent.

4.3.1.2* The AHJ shall determine who is qualified to perform the daily/weekly inspection and the operational checks of fire apparatus.

4.3.1.3 Pump tests and annual aerial tests shall be performed by personnel who are qualified in accordance with NFPA 1071, *Standard for Emergency Vehicle Technician Professional Qualifications*, or the equivalent or by an organization that is accredited for inspection and testing systems on fire apparatus in accordance with ISO/IEC 17020, *General criteria for the operation of various types of bodies performing inspections*.

4.4 Safety.

4.4.1* Anyone performing operational checks, diagnostic checks, inspections, or maintenance on fire apparatus shall consult the appropriate operator's, service, and maintenance manuals before starting any work on the apparatus.

4.4.2 All safety warnings and recommendations shall be read and followed.

4.4.3* All federal, state, and local laws and regulations governing workplace safety shall be followed when performing maintenance on fire apparatus.

4.4.4 All federal, state, and local laws shall be followed in the use and disposal of chemicals and hazardous materials.

4.4.5 Remediation equipment and methods shall be used prior to and during preventive maintenance when dealing with possible contamination by, and exposure to, hazardous materials, medical and biological waste, and other hazards.

4.4.6 Personal protection, including eye protection, hearing protection, and suitable respirators for breathing protection, shall be used when the maintenance operations require such protection.

4.4.7 A system or method shall be utilized to remove exhaust emissions from an operating engine in a confined area.

4.4.8 Proper methods shall be utilized to lift, support, secure, and stabilize as appropriate, the fire apparatus undergoing maintenance.

4.4.9 Proper tools and equipment shall be selected for the task to be performed.

4.5 Inspections and Maintenance.

4.5.1 The fire apparatus shall meet all federal, state or provincial, and local laws for motor vehicle inspection.

4.5.2* All inspections and maintenance shall be conducted in accordance with the manufacturer's recommended procedures.

4.5.3* It shall be the responsibility of the AHJ to develop and implement a schedule for the operational checking, inspection, diagnostic checking, and maintenance of the fire apparatus and its systems and components in accordance with this document, the manufacturer's recommendations, local experience, and operating conditions.

4.5.4 An operational check and visual check of the fire apparatus shall be performed on a daily/weekly basis to ensure the operational readiness of the unit.

4.5.4.1 Defined systems of the apparatus shall be checked, including the fire pump, aerial device, warning lights, audible warning devices, cab and pump panel instrumentation, seat belts, tires, engine, transmission, drivetrain, and brake system.

4.5.4.2 An inspection form shall be utilized to record the results of the operational and visual check. (*See Annex C.*)

4.5.5* A complete inspection and diagnostic check of the fire apparatus shall be conducted at least as frequently as recommended by the apparatus manufacturer or once per year, whichever comes first.

4.5.6 Component inspections shall be performed at least as frequently as recommended by the manufacturer and when the fire apparatus or any component is suspected or reported to have defects or deficiencies.

4.5.7 All deficiencies found during an inspection shall be repaired or corrected by a qualified person.

4.6 Maintenance and Repairs.

4.6.1 Maintenance and repairs shall be made in accordance with the manufacturer's recommendations.

4.6.2 Parts or components used to maintain or repair the fire apparatus shall meet or exceed the original manufacturer's specifications.

4.7* Documentation.

4.7.1 Records shall be maintained on the results of all apparatus inspections, maintenance requests, preventive maintenance, repairs, and testing.

4.7.2 Separate files shall be established and maintained for each individual fire apparatus.

4.7.3 All records shall be kept for the life of the vehicle and delivered with the vehicle upon transfer or change of ownership.

Chapter 5 Retirement of Fire Apparatus**5.1* General.**

5.1.1 The fire department shall consider safety as the primary concern in the retirement of apparatus.

5.1.2 Retired fire apparatus shall not be used for emergency operations.

Chapter 6 Out-of-Service Criteria**6.1 General.**

6.1.1 It shall be the responsibility of the AHJ to take the apparatus or the defective portion of the apparatus out of service if any of the deficiencies defined in this chapter are encountered.

6.1.2 Where a technician conducts an evaluation of the apparatus to determine if the apparatus or a component should be taken out of service, the technician shall report the findings to the AHJ in writing, with one of the following recommendations:

- (1) The apparatus shall be taken out of service.
- (2) The apparatus shall be retained in service with specified limitations.
- (3) The apparatus shall be retained in service without limitations.

6.1.3 In addition to the defects defined in this chapter, the AHJ shall include out-of-service criteria based on state, provincial, and local regulations; specific manufacturer's recommendations; and requirements established by the fire department.

6.1.4 The apparatus shall be returned to service only after the defects and deficiencies that caused the apparatus to be taken out of service have been corrected and the defective component retested to the component manufacturer's specification and the requirements of this document.

6.1.5 The AHJ shall establish a means to immediately identify that the apparatus is out of service for any operator who might have reason to use the apparatus.

6.1.5.1 Out-of-service apparatus shall be identified by one of the following means:

- (1) Sign on the outside of the driver's door near the door handle
- (2) Special bag that covers the steering wheel
- (3) Large sign on the driver's window
- (4) Highly visible mechanism at the driver's position on the fire apparatus that all members of the fire department recognize as an out-of-service indicator

6.1.5.2 A technician working on a fire apparatus shall identify that a vehicle is out of service or that the apparatus is being serviced using one of the means specified in 6.1.5.1.

6.1.6* If a component or system on the fire apparatus is out of service, but the apparatus is still in service, a means shall be provided on the fire apparatus to immediately identify for the driver/operator which component or system is out of service.

6.1.6.1 Out-of-service components shall be identified using both of the following:

- (1) Distinctive color sign located on the inside of the driver's door identifying which component is out of service
- (2) Highly visible device provided at the component control(s) indicating that the device is out of service

6.1.6.2 Any out-of-service component shall be noted on the daily/weekly check sheet.

6.1.6.3 If the fire pump or the aerial device is out of service, the engagement device shall be disabled so as to prevent operation of the pump or the aerial device.

6.2 Driving and Crew Areas, Apparatus Body, and Compartmentation.

6.2.1 The following deficiencies of the driving and crew areas, the apparatus body, and the compartmentation shall cause the apparatus to be taken out of service:

- (1) Cracked or broken windshield that obstructs the driver's/operator's view
- (2) Missing or broken rearview mirrors that obstruct the driver's/operator's view
- (3) Missing or broken windshield wipers
- (4) Missing or broken door latches
- (5) Missing or broken foot throttle

6.2.2 If a seat belt is torn or has melted webbing, missing or broken buckles, or loose mountings, the following shall apply:

- (1) If it is at a seat other than the driver's seat, that seat shall be taken out of service.
- (2) If it is at the driver's seat, the entire apparatus shall be taken out of service.

6.2.3* If there are deficiencies with the following system or components, a qualified technician shall conduct an out-of-service evaluation and make a written report, including recommendations to the AHJ:

- (1) Body mounting
- (2) Cab mounting
- (3) Steering wheel
- (4) Required cab instrumentation
- (5) Defrosters

6.3 Chassis, Axles, Steering and Suspension Systems, Driveline, Wheels, and Tires.

6.3.1 The following deficiencies of the chassis, axles, steering and suspension systems, driveline, wheels, and tires shall cause the apparatus to be taken out of service:

- (1) The gross axle weight rating (GAWR) shown on the vehicle weight rating label is greater than the tire manufacturer's load rating.
- (2) When weighed in accordance with Section 16.2, the weight on the front axle, the weight on the rear axle, or the total gross weight of the fire apparatus exceeds the values shown on the vehicle weight rating label.



- (3) Tires have cuts in the sidewall that penetrate to the cord.
- (4) *Tires have a tread depth of less than $\frac{1}{32}$ in. (3.2 mm) on any steering axle or $\frac{1}{16}$ in. (1.6 mm) on any nonsteering axle at any two adjacent major tread grooves anywhere on the tire.
- (5) Suspension components are loose, broken, or missing.
- (6) Wheels or rims have the following deficiencies:
 - (a) Bent, broken, cracked, improperly seated, sprung, or mismatched lock or side ring(s)
 - (b) Cracked, broken, or elongated bolt holes
 - (c) Loose, missing, broken, cracked, stripped, or otherwise ineffective fasteners
 - (d) Weld deficiencies, as follows:
 - i. Cracks in welds attaching disc wheel disc to rim
 - ii. Cracks in welds attaching tubeless demountable rim to adapter
 - iii. Welded repair on aluminum wheel(s) on a steering axle
 - iv. Welded repair, other than disc to rim attachment, on steel disc wheel(s) mounted on the steering axle
- (7) Axle flanges have Class 3 leakage.
- (8) An axle has Class 3 leakage.
- (9) Steering components do not meet the requirements of 49 CFR Part 399.211, Appendix G, "Minimum Periodic Inspection Standards."
- (10) A steering component has Class 3 leakage.
- (11) Driveline components do not meet the requirements of 49 CFR 399.211, Appendix G.

6.3.2 A qualified technician shall conduct an out-of-service evaluation of the following tire deficiencies and make a written report, including recommendations to the AHJ:

- (1) Punctures
- (2) Cuts to the cord
- (3) Bulges other than bumps or repairs; repair bulges greater than $\frac{3}{8}$ in. (10 mm), or bulges or knots associated with tread
- (4) Sidewall separation

6.4 Engine Systems.

6.4.1* The following defects and deficiencies of the engine system shall cause the apparatus to be taken out of service:

- (1) Engine that will not crank or start
- (2) Engine system that has Class 3 leakage of oil
- (3) Engine that is overheating
- (4) Oil that contains coolant
- (5) Oil that is diluted with fuel
- (6) Fuel system component that has Class 2 leakage of fuel
- (7) Stop-engine light that fails to turn off after engine is started

6.4.2 If there are deficiencies of the following systems or components, a qualified technician shall conduct an out-of-service evaluation and make a written report, including recommendations to the AHJ:

- (1) Air filter restriction
- (2) Fuel tank, mountings, or straps

6.5 Engine Cooling System.

6.5.1 The following deficiencies of the engine cooling system shall cause the apparatus to be taken out of service:

- (1) Cooling system component that has Class 3 leakage
- (2) Coolant that contains oil
- (3) Cooling system that exceeds maximum operating temperature

6.5.2 If there are deficiencies with the following systems or components, a qualified technician shall conduct an out-of-service evaluation and make a written report, including recommendations to the AHJ:

- (1) Radiator
- (2) Water pump bearing
- (3) Cooling fan
- (4) Coolant system components

6.6 Transmission and Clutch.

6.6.1 The following defects and deficiencies of the transmission and clutch shall cause the apparatus to be taken out of service:

- (1) Automatic transmission that overheats in any range
- (2) Automatic transmission that has a "do not shift" light on
- (3) Transmission components that have Class 3 leakage of transmission oil
- (4) Transmission oil contaminated with coolant

6.6.2 If there are deficiencies of the following systems or components, a qualified technician shall conduct an out-of-service evaluation and make a written report, including recommendations to the AHJ:

- (1) Clutch components
- (2) Transmission components
- (3) Shift linkages

6.7 Low-Voltage and Line Voltage Electrical Systems.

6.7.1 The following defects and deficiencies of the low-voltage electrical system and the line voltage electrical system shall cause the apparatus to be taken out of service:

- (1) Legally required lighting (DOT lighting) or horn that is not operational
- (2) Ignition system that is not operational
- (3) Charging system that is not operational
- (4)*Any failure of the warning light system that creates any position around the apparatus from which no warning light is visible

6.7.2 If there are deficiencies in the grounding and bonding system, a qualified technician shall conduct an out-of-service evaluation and make a written report, including recommendations to the AHJ.

6.7.3 If any of the following conditions exist, a qualified technician shall conduct an out-of-service evaluation and make a written report, including recommendations to the AHJ:

- (1)*Inoperative siren
- (2) Overheating of power source and systems
- (3) Tripping of circuit breakers [ground fault circuit interrupter (GFCI), if applicable]
- (4) Line voltage power source producing high or low voltage or frequency
- (5) Damaged receptacles or observed electrical shock hazard

6.8 Braking Systems.

6.8.1 Air Brake Systems.

6.8.1.1* The following deficiencies of the air brake system shall cause the apparatus to be taken out of service:

- (1) Service brakes that have an air pressure drop of more than 2 psi (13.8 kPa) in 1 minute for straight chassis or more than 3 psi (20.7 kPa) in 1 minute for combination chassis, with the engine stopped and the service brakes released
- (2) Leak-down rate (time) of the applied side of the air brake that is more than 3 psi (20.7 kPa) in 1 minute for

straight chassis or more than 4 psi (27.6 kPa) in 1 minute for combination chassis, with the engine stopped and the service brakes applied

- (3) Brakes that are out of adjustment
- (4) Braking system components that are not operational
- (5) Service brake that does not meet test or DOT requirements
- (6) Parking (spring) brake operation that does not meet parking brake tests or standards
- (7) Air compressor that fails to build air pressure from 85 psi to 100 psi (586 kPa to 690 kPa) in 45 seconds, with engine at full rpm
- (8) Air compressor that fails to maintain 80 psi to 90 psi (552 kPa to 621 kPa) pressure in the system, with the service brakes applied and the engine at idle, or air compressor that fails to fill the air system to the air compressor governor cutout pressure with the service and parking brakes released
- (9) Friction surfaces, brake shoes, or disc brake pads that have grease or oil on them
- (10) Brake linings or pads that are worn beyond the brake system manufacturer's minimum specifications
- (11) Rotors and drums that are worn beyond the brake system manufacturer's minimum specifications
- (12) Air gauge or audio low-air warning device that has failed

6.8.1.2 If the antilock braking system (ABS) warning indicator indicates a problem, a qualified technician shall conduct an out-of-service evaluation and make a written report, including recommendations to the AHJ.

6.8.2 Hydraulic Brake Systems.

6.8.2.1* The following deficiencies of the hydraulic brake system shall cause the apparatus to be taken out of service:

- (1) Brake system components that have Class 2 leakage of brake fluid
- (2) Friction surfaces, brake shoes, or disc brake pads that have grease or oil on them
- (3) Braking system components that are not operational
- (4) Braking operation that does not meet braking tests or standards
- (5) Parking (service) brake operation that does not meet parking brake tests or standards
- (6) Brake warning light that is activated or brake pedal that falls away or drifts toward the floor when brake pressure is applied
- (7) Brake linings or pads that are worn beyond the brake system manufacturer's minimum specifications
- (8) Rotors and drums that are worn beyond the brake system manufacturer's minimum specifications

6.8.2.2 If the ABS warning indicator indicates a problem, a qualified technician shall conduct an out-of-service evaluation and make a written report including recommendations to the AHJ.

6.8.3 Air-Over-Hydraulic Brake Systems. The requirements of 6.8.1 and 6.8.2 shall apply to the applicable portion of an air-over-hydraulic brake system.

6.8.4 Wheel Chocks. If the apparatus is not equipped with two wheel chocks, mounted in readily accessible locations, the condition shall be reported to the AHJ.

6.9 Fire Pump System.

6.9.1 The following deficiencies of the fire pump system shall cause the pumping system to be taken out of service:

- (1) Pump that will not engage

- (2) Pump shift indicators in cab and on operator's panel that do not function properly
- (3) Pressure control system that is not operational
- (4) Pump transmission components that have Class 3 leakage of fluid
- (5) Pump operator's panel throttle that is not operational
- (6)*Pump operator's engine speed advancement interlock that is not operational

6.9.2 If there are deficiencies of the following systems or components, a qualified technician shall conduct an out-of-service evaluation and make a written report, including recommendations to the AHJ:

- (1) Pump transmission lubricant
- (2) Valves
- (3) Valve controls
- (4) Pump piping
- (5) Pressure-indicating devices
- (6) Water tank
- (7) Water level indicator

6.9.3 If pump shaft seals leak beyond the manufacturer's specifications, a qualified technician shall conduct an out-of-service evaluation of the problem and make a written report, including recommendations to the AHJ.

6.9.4 If the pump test indicates a deficiency, a qualified technician shall conduct an out-of-service evaluation and make a written report, including recommendations to the AHJ.

6.10 Aerial Device Systems.

6.10.1 The following deficiencies of the aerial device and its systems shall cause the aerial device to be taken out of service:

- (1) Power takeoff (PTO) that will not engage
- (2) Stabilizer system that is not operational
- (3) Aerial device that is not operational
- (4) Hydraulic system components that are not operational
- (5) Cable sheaves that are not operational
- (6) Cables that are frayed
- (7) Base and section rails that show ironing beyond the manufacturer's recommendations
- (8) Aerial device that is structurally deformed
- (9) Torque box fasteners that are broken or missing
- (10) Turntable fasteners that are broken or missing

6.10.2 If there are deficiencies of the following systems or components, a qualified technician shall conduct an out-of-service evaluation and make a written report, including recommendations to the AHJ:

- (1) Hydraulic relief valve
- (2) Hydraulic system components
- (3) Emergency hydraulic system
- (4) Visual and audible alarm systems
- (5) Aerial lighting system
- (6) Aerial intercom system
- (7) Labels or warning signs
- (8) Aerial water delivery system

6.10.3 A qualified technician shall conduct an out-of-service evaluation of the following problems and make a written report, including recommendations to the AHJ:

- (1) Rollers and slides that are worn beyond manufacturer's recommendations
- (2) Rotation bearing that has clearances beyond the manufacturer's recommendations

Chapter 7 Inspection and Maintenance of the Chassis, Driving and Crew Compartment, and Body

7.1 General. All components and systems commonly found on or in the chassis, driving compartment, crew compartment, and body shall be inspected and maintained in accordance with the manufacturer's instructions and this chapter.

7.2 Frame and Suspension.

7.2.1 All frame rails and members shall be inspected for defects, structural integrity, corrosion, perforations, and missing or loose parts.

7.2.2 All suspension components including, but not limited to, the following shall be inspected for defects, missing or loose parts, and functional operation and shall be lubricated:

- (1) Springs and spring hangers
- (2) Air springs (bags), mounting brackets, and attaching hardware
- (3) Equalizer beams and torque arms
- (4) Shock absorbers

7.2.3 The frame and suspension shall be inspected for proper alignment.

7.3 Axles, Tires, and Wheels.

7.3.1 All axle components including, but not limited to, the following shall be inspected for security of mounting, structural integrity, deformation, abnormal wear, and leakage; shall be functionally operated; and shall be lubricated:

- (1) Ball joints
- (2) King pins
- (3) Spindles and bushings
- (4) Attaching hardware
- (5) Axle beams and housings
- (6) Axle shafts
- (7) Axle power dividers
- (8) Differentials and controls
- (9) Two-speed axle shift units
- (10) Upper and lower control arms

7.3.2 Wheel bearings and seals shall be cleaned; shall be inspected for deformation, wear, cracks, and leakage; and shall be lubricated.

7.3.3* Tires shall be inspected for damage and shall be inflated to the tire manufacturer's recommended pressure.

7.3.4* Tires shall be replaced at least every 7 years or more frequently when the tread wear exceeds state or federal standards as determined by measuring with a tread depth gauge. [See 6.3.1(4).]

7.3.5* Wheel-attaching nuts shall be torqued to the wheel manufacturer's recommendation.

7.3.6 Wheels and rims shall be inspected for cracks, deformation, structural integrity, and corrosion.

7.4 Engine.

7.4.1 The engine oil shall be inspected for contamination and maintained at the level specified by the engine manufacturer.

7.4.2 The engine shall be inspected for security of mounting and fluid leaks.

7.4.3 Engine oil and filters shall be serviced in accordance with the engine manufacturer's severe service recommendation. If no

severe service recommendation exists, the shortest interval recommended by the engine manufacturer, based on time or mileage, shall be followed.

7.4.4 The diagnostic codes for electronically controlled engines shall be reviewed for types and frequency of error codes that have been logged.

7.4.5* The engine performance shall be maintained in accordance with the engine manufacturer's recommendations.

7.4.6 Engine braking systems shall be maintained in accordance with the manufacturer's recommendations.

7.5 Engine Cooling System.

7.5.1 The engine coolant shall be inspected for contamination and maintained at the level specified by the manufacturer.

7.5.2 The radiator assembly shall be inspected and cleaned of dirt, debris, and obstructions to airflow.

7.5.3 All hoses and fittings shall be inspected for condition and leakage.

7.5.4 The water pump(s) shall be inspected for condition and leakage.

7.5.5 The cooling system shall be pressure tested for leakage.

7.5.6 All belts shall be inspected for wear, deformation, and proper adjustment.

7.5.7 The chemical components of the coolant shall be tested and maintained at the proper balance.

7.5.8 Cooling system temperature indicators and gauges shall be diagnostically checked.

7.5.9 Temperature control devices including, but not limited to, the following shall be diagnostically checked:

- (1) Thermostats
- (2) Clutch fans
- (3) Radiator shutters
- (4) Electric cooling fans

7.5.10 Auxiliary heat exchangers installed in the engine cooling system shall be inspected for security of mounting, deformation, and leaks.

7.6* Engine Fuel System.

7.6.1 Fuel filters and fuel-water separators shall be maintained in accordance with the manufacturer's recommendations.

7.6.2 The fuel tank, lines, and all connections shall be inspected for security of mounting, deformation, and leakage.

7.6.3 The carburetor or the injection pump and injectors shall be maintained in accordance with the engine manufacturer's recommendations.

7.6.4 Gauges, indicators, and sending units shall be diagnostically checked.

7.6.5* All mechanical throttle linkage and stops shall be inspected for proper adjustment and diagnostically checked.

7.6.6 All electronic throttle components and throttle position sensors (TPS) shall be inspected for counts and diagnostically checked.

7.7 Engine Air Intake System.

7.7.1 The engine air intake system shall include, but not be limited to, the following:

- (1) Air cleaner element
- (2) Piping
- (3) Turbocharger
- (4) Air after-cooler
- (5) Intercooler
- (6) Air-to-air cooler
- (7) Blower
- (8) Ember separator

7.7.2 The engine air intake system shall be maintained in accordance with the manufacturer's severe service recommendation. If no severe service recommendation exists, the shortest service interval recommended by the engine manufacturer, based on time or mileage, shall be followed.

7.7.3 Where engines are equipped with a charged air after-cooler, it shall be inspected visually for outward signs of damage or deformation.

7.7.4 All hoses, tubes, and fittings shall be inspected for deformation and leakage.

7.7.5 The airflow shall be monitored for restriction greater than that recommended by the engine manufacturer.

7.8 Engine Exhaust System.

7.8.1 The engine exhaust system shall include, but not be limited to, the following:

- (1) Exhaust manifold(s)
- (2) Exhaust pipes
- (3) Muffler(s)
- (4) Tailpipe(s)
- (5) Exhaust clamps, brackets, and mounting hardware
- (6) Turbocharger
- (7) Catalytic converter(s)
- (8) Exhaust filtration system

7.8.2 The exhaust system shall be inspected for security of mounting, deformation, and exhaust leaks and shall be maintained in accordance with the engine manufacturer's recommendations.

7.9 Transmission.

7.9.1 The transmission shall be inspected for security of mounting, structural integrity, and leakage and shall be diagnostically checked.

7.9.2 The clutch and linkage, if the fire apparatus is so equipped, shall be inspected for condition and adjustment, diagnostically checked, and maintained in accordance with the manufacturer's recommendations.

7.9.3 Transmission lubricants and filters shall be inspected for contamination, and lubricants shall be maintained at the level specified by the manufacturer.

7.9.4 The lubricant and filters shall be serviced in accordance with the transmission manufacturer's severe service recommendation. If no severe service recommendation exists, the shortest interval recommended by the transmission manufacturer, based on time or mileage, shall be followed.

7.9.5 The transmission controls and shift linkage shall be inspected for condition and maintained in accordance with the manufacturer's recommendations.

7.9.6 All transmission indicators and gauges shall be tested for proper operation and accuracy.

7.9.7 The diagnostic codes for all electronically controlled transmissions shall be reviewed for types and frequency of error codes that have been logged.

7.9.8 Power takeoffs (PTOs) shall be inspected for security of mounting and leakage and shall be diagnostically checked.

7.9.9 The lockup system for pumps and other accessories shall be inspected for leakage and shall be diagnostically checked.

7.9.10 Transmission braking systems shall be maintained in accordance with the manufacturer's recommendations.

7.9.11 Auxiliary heat exchangers installed in the transmission cooling system shall be inspected for security of mounting, deformation, and leaks.

7.10 Driveline.

7.10.1 All drive shafts, universal joints, carrier bearings, flanges, bearing cap bolts, and slip yokes shall be inspected for alignment, security of mounting, and wear and shall be lubricated.

7.10.2 Driveline retarding systems shall be cleaned, shall be inspected for security of mounting, shall be diagnostically checked, and shall be lubricated.

7.11 Steering System.

7.11.1 The steering system shall include, but not be limited to, the following components:

- (1) Power steering pump, filters, and reservoir
- (2) Steering valve(s), cylinders, and hydraulic components
- (3) Steering gear box(es)
- (4) Steering gear mounting brackets
- (5) Steering arms, drag links, pitman arms, tie rods, and tie rod ends
- (6) Steering column assembly and steering wheel

7.11.2 All steering system components shall be inspected for structural integrity, security of mounting, leakage, and condition; shall be diagnostically checked; and shall be lubricated.

7.11.2.1 The surrounding vehicle components shall be inspected for indications that the wheels or tires have been rubbing during steering.

7.11.2.2 Both the left and right steering axle stops shall be diagnostically checked to ensure the steering gear hydraulics relieve before contacting the steering stops.

7.11.2.3 Steering Gear Mounting Bracket.

7.11.2.3.1 The steering gear mounting bracket shall be cleaned and inspected for cracks.

7.11.2.3.2 All steering gear mounting bracket fasteners shall be inspected for proper installation, grade, and torque.

7.11.2.4 The steering linkage assembly shall be inspected to ensure that the pinch bolts, cotter pins, and other retaining hardware are in place and properly secured.

7.11.2.5 The steering wheel shall be rotated to check for steering backlash.

7.11.3 The steering gear box(es) and power steering reservoir lubricant levels shall be maintained in accordance with the manufacturer's recommendations.



7.11.4 The steering valve(s), steering arms, drag links, pitman arms, tie rod ends, and steering column assembly shall be lubricated.

7.11.5 All steering pump belts, hoses, and lines shall be inspected for wear, adjustment, and deformation.

7.11.6 Electronic steering controls and indicators shall be maintained in accordance with the manufacturer's recommendations.

7.12 Braking System.

7.12.1* The braking system shall be inspected and maintained in accordance with the manufacturer's severe service recommendation. If no severe service recommendation exists, the shortest interval recommended by the braking system manufacturer, based on time or mileage, shall be followed.

7.12.2 The parking brake shall be inspected for structural integrity, security of mounting, missing or broken parts, and wear and shall be diagnostically checked.

7.12.3 The parking brake controls and activating mechanism shall be inspected for structural integrity, security of mounting, and missing or broken parts; shall be diagnostically checked; and shall be lubricated.

7.12.4 The brake linings shall be replaced in accordance with the brake manufacturer's severe service recommendation when they are contaminated, when the lining is worn to the minimum thickness for safe operation as defined by the brake manufacturer, or when the brake drum or rotor is replaced.

7.12.5 The drums or rotors shall be inspected during scheduled maintenance, when there is a suspected problem, or at the time of brake lining replacement, and the inspection shall consist of, but not be limited to, the following:

- (1) Evidence of extensive heat or heat cracking
- (2) Out of round
- (3) Wear beyond manufacturer's specifications
- (4) Rust
- (5) Taper
- (6) Rotor parallelism
- (7) Metal fatigue

7.12.6 Machining of brake drums or rotors shall be done only in accordance with manufacturer's recommendations.

7.12.7 All components of the braking system shall be inspected for damage and wear when performing a brake overhaul.

7.12.8 Antilock Braking Systems.

7.12.8.1 Antilock braking systems (ABS), including the electronic control unit, cables, switches, relays, sensors, and valves, shall be inspected for any deficiencies and shall be diagnostically checked.

7.12.8.2 The ABS electronic control unit (ECU) diagnostic codes shall be reviewed for types and frequency of error codes that have been logged.

7.12.9 If the fire apparatus has a hydraulic brake system, the components to be inspected and maintained shall include, but not be limited to, the following:

- (1) Pedal and linkage
- (2) Brake switches
- (3) Master cylinder
- (4) Brake booster
- (5) Hydraulic lines
- (6) Valves
- (7) Wheel cylinders or calipers

- (8) Brake shoes or pads
- (9) Brake drums or rotors
- (10) Warning devices
- (11) Mounting hardware
- (12) Fluid level and contamination

7.12.10 If the fire apparatus has an air brake system, the components to be inspected and maintained shall include, but not be limited to, the following:

- (1) Air compressor
- (2) Pedal assembly
- (3) All valves
- (4) Hoses and lines
- (5) Brake switches
- (6) Brake air chambers
- (7) Slack adjusters
- (8) Cams and wedges
- (9) Brake shoes or pads
- (10) Brake drums or rotor
- (11) Calipers
- (12) Air dryers
- (13) Drain valves
- (14) Air tanks
- (15) Warning devices
- (16) Mounting hardware

7.12.10.1 If air accessories are connected to the chassis air brake system, the requirements of 7.12.10.1.1 and 7.12.10.1.2 shall apply.

7.12.10.1.1 The air brake system pressure protection valve(s) shall be diagnostically checked to the shutoff point.

7.12.10.1.2 The pressure protection valve shall prevent the air accessories from drawing air from the air brake system when the air pressure drops below 80 psi (552 kPa) to ensure adequate air pressure for the braking system.

7.12.10.2 Air reservoir tanks, air dryers, and drains shall be inspected for security of mounting, deformation, and leakage and shall be maintained in accordance with the manufacturer's recommendations.

7.12.10.3 All valves, lines, cylinders, and chambers shall be inspected for security of mounting, deformation, and leakage and shall be diagnostically checked.

7.12.10.4 The compressor and inlet filter system shall be inspected for security of mounting and shall be maintained in accordance with the manufacturer's recommendations.

7.12.10.5 All chassis air system belts shall be inspected for wear and deformation and shall be maintained at the manufacturer's recommended adjustment.

7.12.10.6 The cut-in and cut-out pressure settings of the air compressor governor shall be tested and maintained at the manufacturer's recommended settings.

7.12.10.7 The low-air warning systems shall be tested to ensure that activation occurs at the manufacturer's recommended setting.

7.12.10.8 Air pressure indicators shall be diagnostically checked.

7.12.10.9 Leak-down rate (time) of the applied side of the air brake system shall be tested with the engine stopped and the service brakes applied, and the air pressure shall not drop more than 3 psi (20.7 kPa) in 1 minute for a straight vehicle or more than 4 psi (27.6 kPa) in 1 minute for a combination vehicle.

7.12.10.10 Leak-down rate (time) of the supply-side of the chassis air system shall be tested with the engine stopped and the service brakes released, and the air pressure shall not drop more than 2 psi (13.8 kPa) in 1 minute for a straight vehicle or more than 3 psi (20.7 kPa) in 1 minute for a combination vehicle.

7.13 Chassis Air-Powered Accessories. All chassis air-powered accessories including, but not limited to, the following shall be diagnostically checked:

- (1) Air horn
- (2) Windshield wiper and washer
- (3) Air-ride seats
- (4) Air-powered steps and cab tilting systems
- (5) Fire pump shift and valves

7.14 Crew and Passenger Compartments.

7.14.1 All glass, windows, and mirrors shall be inspected for condition and shall be diagnostically checked.

7.14.2 All seats shall be inspected for security of mounting and condition and shall be diagnostically checked.

7.14.3 All seat belts shall be inspected for security of mounting and condition and shall be diagnostically checked.

7.14.4 Doors, door hinges, latches, and door stops shall be inspected for security of mounting and condition, shall be diagnostically checked, and shall be lubricated.

7.14.5 All components of the cab mounting system including, but not limited to, the following shall be inspected for security of mounting and deformation:

- (1) Mounting brackets
- (2) Cab base structure
- (3) Resilient cushions
- (4) Securing fasteners

7.14.6* All equipment mounting systems including, but not limited to, mounting systems for the following shall be inspected for security of mounting and deformation and shall be maintained free of corrosion:

- (1) Radios, computers, and siren controls
- (2) Self-contained breathing apparatus (SCBA)
- (3) Portable lights
- (4) Hand tools
- (5) Emergency medical service (EMS) equipment
- (6) Books, street directories, and maps

7.14.7 Cab Tilting Systems. If the apparatus has a cab tilting system, it shall be inspected and maintained in accordance with 7.14.7.1 and 7.14.7.2.

7.14.7.1* All components of the cab tilting system including, but not limited to, the following shall be inspected for security of mounting and leaks and shall be diagnostically checked:

- (1) Switches and remote controls
- (2) Interlocks
- (3) Motors and pumps
- (4) Reservoirs
- (5) Hoses and fittings
- (6) Cylinders and lifting devices
- (7) Cab support devices
- (8) Split cab seals
- (9) Pivot points
- (10) Latches and hold-down devices

7.14.7.2 Fluids shall be inspected for contamination and maintained to the levels recommended by the manufacturer.

7.15 Body and Compartmentation.

7.15.1 All compartments and storage areas shall be inspected for structural integrity, deformation, and leaks.

7.15.1.1 Hinges, latches, and seals shall be diagnostically checked and shall be lubricated.

7.15.1.2 Doors shall be diagnostically checked for correct operation and position.

7.15.1.3 The hazard warning light and interlocks associated with, but not limited to, the following conditions shall be diagnostically checked:

- (1) Open passenger or equipment compartment doors
- (2) Ladder or equipment rack not in the stowed position
- (3) Deployed stabilizer system
- (4) Extended powered light tower

7.15.2 All steps, platforms, handrails, and access ladders shall be inspected for security of mounting, structural integrity, and deformation.

7.15.2.1 All slip-resistant surfaces shall be inspected for security of mounting and condition.

7.15.2.2 All mechanical steps shall be diagnostically checked and shall be lubricated.

7.15.3 All equipment mounting racks and brackets shall be inspected for security of mounting and deformation, shall be diagnostically checked, and shall be lubricated.

7.15.4* All finishes and reflective striping shall be inspected for defects, corrosion, and damage.

7.15.5* Where required, all signs and labels shall be inspected for their presence and any defects, corrosion, and damage.

7.16 Powered Equipment Racks. If the apparatus is equipped with powered equipment racks, the racks shall be inspected and maintained in accordance with 7.16.1 through 7.16.5.

7.16.1 All locks used to hold equipment racks in the road travel position and all interlocks to prevent operation of equipment racks when the fire apparatus is in motion shall be inspected for security of mounting and deformation.

7.16.2 Racks and interlocks shall be diagnostically checked.

7.16.3 All warning lights and visual signals for the equipment racks shall be diagnostically checked.

7.16.4 Reflective striping or reflective paint shall be inspected for defects, corrosion, and damage.

7.16.5 Equipment-holding devices shall be inspected for security of mounting and deformation, shall be diagnostically checked, and shall be lubricated.

Chapter 8 Inspection and Maintenance of Low-Voltage Electrical Systems

8.1 General. Low-voltage electrical systems shall be inspected and maintained in accordance with this chapter.

8.1.1 All electrical equipment on the apparatus shall be inspected and maintained, regardless of whether it is specified in Sections 8.2 through 8.12.



8.1.2 All components of the low-voltage electrical system shall meet the following criteria:

- (1) They shall be kept clean and free of accumulated dirt or corrosion.
- (2) They shall be maintained in accordance with manufacturer's instructions and schedules.
- (3) They shall be securely mounted.
- (4) They shall be securely connected to their electrical supply and ground.

8.2 Starting System. All components of the starting system including, but not limited to, the following shall be inspected for security of mounting and deformation and shall be diagnostically checked:

- (1) Batteries, cabling, and connections
- (2) Cranking motor
- (3) Solenoid, relays, and switches
- (4) Interlock systems

8.3 Wiring. All wiring and wire looms shall be inspected for security of mounting, tight connections, proper routing, presence of grommets, condition, and cleanliness.

8.4 Batteries. The battery(ies) shall be tested for storage and performance capabilities in accordance with the manufacturer's recommendations.

8.5 Charging System.

8.5.1 All components of the charging system including, but not limited to, the following shall be inspected for security of mounting, deformation, and alignment and shall be diagnostically checked:

- (1) Alternator, regulator, and associated wiring and cables
- (2) Isolators
- (3) Alternator drive belts
- (4) Solenoids, relays, switches, and instrumentation
- (5) Interlock systems

8.5.2* The alternator shall be diagnostically checked.

8.6 Ignition System. All components of the ignition system including, but not limited to, the following shall be inspected for security of mounting and deformation and shall be diagnostically checked:

- (1) Associated wiring and cables
- (2) Solenoid, relays, switches, instrumentation, and lighting
- (3) Primary and secondary systems
- (4) Glow plugs

8.7 Automatic Electrical Load Management System.

8.7.1 If so equipped, all components of the automatic electrical load management system including, but not limited to, the following shall be inspected for security of mounting and deformation:

- (1) Electronic hardware
- (2) Associated wiring and cables
- (3) Relays, controls, and indicators
- (4) Low-voltage warning devices

8.7.2* The electrical load management system shall be checked for activation and operation of low-voltage warning devices in accordance with the manufacturer's recommendations.

8.8 Miscellaneous Electrical Components. Miscellaneous electrical components including, but not limited to, the following shall be inspected for security of mounting and deformation and shall be diagnostically checked:

- (1) Battery conditioners and chargers

- (2) Shoreline receptacles
- (3) Radios and intercoms
- (4) Converters and inverters
- (5) Fast idle system
- (6) Interlock system(s)
- (7) Operator alert devices
- (8) Other electrical components on the apparatus not otherwise specified in Section 8.8(1) through (7)

8.9 Apparatus Lighting. All fire apparatus lighting including, but not limited to, the following shall be inspected for security of mounting and deformation and shall be diagnostically checked:

- (1) Headlights
- (2) Marker lights
- (3) Clearance lights
- (4) Turn signals and hazard lights
- (5) Brake lights
- (6) Backup lights
- (7) Dash lights
- (8) Other fire apparatus lighting equipment on the apparatus not otherwise specified in Section 8.9(1) through (7)

8.10 Work Lighting. All work lighting including, but not limited to, the following shall be inspected for security of mounting and deformation and shall be diagnostically checked:

- (1) Ground lights
- (2) Step lights
- (3) Flood, spot, and scene lights
- (4) Cab interior lights
- (5) Compartment lights
- (6) Other work lighting on the apparatus not otherwise specified in Section 8.10(1) through (5)

8.11 Electrical Accessories. All electrical accessories including, but not limited to, the following shall be diagnostically checked:

- (1) Heater and defroster
- (2) Air-conditioning system
- (3) Windshield wipers and washers
- (4) Instrumentation
- (5) Traffic preemption
- (6) Other electrical accessories on the apparatus not otherwise specified in Section 8.11(1) through (5)

8.12 Warning Devices. All warning devices including, but not limited to, the following shall be inspected for security of mounting and deformation and shall be diagnostically checked:

- (1) Emergency warning lights
- (2) Electric and electronic sirens
- (3) Automotive traffic horn
- (4) Air horns
- (5) Backup alarm
- (6) Other warning devices on the apparatus not otherwise specified in Section 8.12(1) through (5)

Chapter 9 Inspection and Maintenance of Water Pumping Systems and Water Tanks

9.1 General.

9.1.1 If the fire apparatus is equipped with a fire pump, auxiliary pump, industrial pump, or transfer pump, the pump shall be inspected and maintained in accordance with Section 9.2 and the component manufacturer's recommendations.

9.1.2 If the fire apparatus is equipped with a water tank, the tank shall be inspected and maintained in accordance with Section 9.3 and the component manufacturer's recommendations.

9.2 Fire Pump, Auxiliary Pump, Industrial Pump, and Transfer Pump.

9.2.1* General. All fire pumps, auxiliary pumps, industrial pumps, and transfer pumps shall be inspected for security of mounting, structural integrity, and leakage and shall be diagnostically checked.

9.2.2 Pump Shaft Packing or Mechanical Seals. All pump shaft packing or mechanical seals shall be inspected and maintained in accordance with the manufacturer's recommendations.

9.2.3 Renewable Anodes and Intake Strainers. Renewable anodes, intake strainers, or any other means to prevent galvanic corrosion shall be inspected for condition and replaced if necessary.

9.2.4 Pump Drive System.

9.2.4.1* The pump drive system shall be inspected for security of mounting and leakage, shall be diagnostically checked, and shall be lubricated as required by the component manufacturer.

9.2.4.2* All pump shift controls, pump shift indicators located in the driving compartment and on the operator's panel, engine speed advancement interlocks, and any other interlocks of the pump drive system shall be inspected for security of mounting and leakage; shall be diagnostically checked; and shall be lubricated as required.

9.2.4.3 All fluids in the pump drive system shall be inspected for contamination and maintained at the level and condition specified by the component manufacturer.

9.2.5 Piping and Valves. All pump piping, valves and valve controls, fire hose connections, caps, chains, and gaskets shall be inspected for security of mounting, structural integrity, proper valve operation, deformation, corrosion, and leakage and shall be lubricated as required by the component manufacturer.

9.2.6 Instrumentation and Gauges. All instrumentation, gauges, and lighting shall be inspected for security of mounting and condition and shall be diagnostically checked.

9.2.7 Pump Controls. All pump control systems including, but not limited to, the following shall be diagnostically checked:

- (1) Engine speed control and interlock
- (2) Pressure control devices
- (3) Transfer valve
- (4) Transmission lockup system

9.2.8 Pump Priming System.

9.2.8.1 The pump priming system shall be inspected for security of mounting and leakage and shall be diagnostically checked.

9.2.8.2 The priming fluid, if required, shall be inspected for contamination and proper type and shall be maintained at the level recommended by the component manufacturer.

9.2.9 Pump Drive Engine. If the pump has a separate drive engine, that engine shall be inspected and maintained in accordance with Sections 7.4 through 7.8, as applicable, and in accordance with the manufacturer's recommendations.

9.3 Water Tanks. If the apparatus is equipped with a water tank, the tank shall be inspected for security of mounting, structural integrity, deformation, and leakage and shall be maintained in accordance with 9.3.1 and 9.3.2 and the component manufacturer's recommendations.

9.3.1 The tank sumps, if equipped with a sump cleanout, shall be cleaned.

9.3.2 Where so equipped, anodes and other means to prevent galvanic corrosion shall be inspected and maintained as recommended by the manufacturer.

Chapter 10 Inspection and Maintenance of Aerial Devices

10.1 General. If the fire apparatus is equipped with an aerial ladder, elevating platform, or water tower, the aerial device and its associated systems shall be inspected and maintained in accordance with this chapter.

10.2 Inspection. The aerial device shall be inspected in accordance with Chapter 19.

10.3 Maintenance. The aerial device and its associated systems shall be maintained in accordance with the aerial device manufacturer's recommendations.

10.4 Air Storage Systems.

10.4.1 If the aerial device has an air storage system, the air storage tanks shall be inspected to verify that hydrostatic test dates are within the periods specified by the manufacturers and the applicable governmental agencies.

10.4.2 Test reports shall be reviewed to verify that the air has been tested and is in accordance with NFPA 1989, *Standard on Breathing Air Quality for Emergency Services Respiratory Protection*.

Chapter 11 Inspection and Maintenance of Foam Proportioning Systems

11.1* General. If the fire apparatus is equipped with a foam proportioning system, the system shall be inspected and maintained in accordance with this chapter.

11.2 System Components.

11.2.1 All components of the foam proportioning system shall be maintained in accordance with the recommendations of the foam system manufacturer.

11.2.2 All components of the foam proportioning system shall be inspected for security of mounting, structural integrity, and leakage and shall be diagnostically checked.

11.3* Cleaning. The foam proportioning system components not designed to stay in continuous contact with foam concentrate shall be thoroughly flushed after each use to ensure that all piping and components are clear of all foam concentrate.

11.4 Instrumentation and Controls. All instrumentation, gauges, and controls shall be inspected for security of mounting and condition and shall be diagnostically checked.

11.5 Strainer or Filter. Where a foam concentrate strainer(s) or filter(s) is utilized, the strainer/filter assembly shall be serviced at routine scheduled intervals.



11.6 Foam Concentrate Pump.

11.6.1 Where the foam proportioning system is equipped with a foam concentrate pump, it shall be maintained as recommended by the manufacturer.

11.6.2 The oil for the pump lubrication system shall be inspected for possible water/foam contamination and shall be maintained at the level recommended by the manufacturer.

11.7 Foam Concentrate or Foam Solution Tanks.

11.7.1 All foam concentrate or foam solution tanks shall be inspected for security of mounting, structural integrity, deformation, and leakage.

11.7.2 Foam Concentrate Inspection.

11.7.2.1 At least annually, a visual inspection shall be made of the foam concentrate(s) in the apparatus storage tank(s) for evidence of sludging or deterioration.

11.7.2.2 If evidence of sludging or deterioration is observed, the foam concentrate shall be replaced or tested to determine if it is suitable for continued use.

11.7.2.3 Foam concentrates that have exceeded the shelf life specified by the concentrate manufacturer or that the test results determine are not suitable for continued use shall be replaced.

11.8 Diagnostic Check. The foam system shall be operated to demonstrate the ability of the system to discharge foam solution or equivalent.

Chapter 12 Inspection and Maintenance of Compressed Air–Foam Systems (CAFS)

12.1 General. If the fire apparatus is equipped with a compressed air–foam system (CAFS), the system shall be inspected and maintained in accordance with this chapter.

12.2 System Components.

12.2.1 All components of the compressed air–foam system shall be maintained in accordance with the recommendations of the manufacturer.

12.2.2 All components of the compressed air–foam system shall be inspected for security of mounting, structural integrity, and leakage and shall be diagnostically checked.

12.2.3 The foam proportioning system shall be maintained, serviced, and flushed as required by Chapter 11.

12.3 Compressed Air Source.

12.3.1 General. The components of the compressed air source including, but not limited to, the following shall be inspected for security of mounting, deformation, cleanliness, and leaks and shall be diagnostically checked as recommended by the manufacturer:

- (1) Filters
- (2) Piping, clamps, tubing, and hose
- (3) Moisture drains
- (4) Air-pressure relief valves
- (5) Brackets on the air intake system

12.3.2 Diagnostic Check. The air compressor shall be diagnostically checked as recommended by the manufacturer.

12.3.3 Air-Cooled Engine-Driven Air Compressor.

12.3.3.1* All components of an air-cooled engine-driven air compressor shall be inspected for security of mounting, deformation, cleanliness, and leaks.

12.3.3.2 The engine shall be inspected and maintained in accordance with the following portions of this standard:

- (1) Subsections 7.4.1 through 7.4.5
- (2) Sections 7.6 through 7.8

12.3.4 Water-Cooled Engine-Driven Air Compressor.

12.3.4.1 All components of a water-cooled engine-driven air compressor shall be inspected for security of mounting, deformation, cleanliness, and leaks.

12.3.4.2 The air compressor shall be diagnostically checked as recommended by the manufacturer.

12.3.4.3 The engine shall be inspected and maintained in accordance with the following portions of this standard:

- (1) Subsections 7.4.1 through 7.4.5
- (2) Subsections 7.5.1 through 7.5.9
- (3) Sections 7.6 through 7.8

12.3.5 Power Takeoff (PTO)–Driven Air Compressor.

12.3.5.1 All components of a PTO-driven air compressor including, but not limited to, the following shall be inspected for security of mounting, deformation, and leaks and shall be diagnostically checked as recommended by the manufacturer:

- (1) PTO
- (2) Drive shafts
- (3) Transfer case
- (4) Gear box
- (5) Air compressor

12.3.5.2 All fluids in the PTO system(s) shall be inspected for contamination and shall be maintained at the level recommended by the manufacturer.

12.3.6 Hydraulic-Driven Air Compressor.

12.3.6.1 All components of a hydraulic-driven air compressor including, but not limited to, the following shall be inspected for security of mounting, deformation, and leaks and shall be diagnostically checked as recommended by the manufacturer:

- (1) Hydraulic pump
- (2) Hydraulic motor
- (3) Hydraulic fluid reservoir
- (4) Hydraulic fluid cooler
- (5) Control systems
- (6) Hose, lines, and valves

12.3.6.2 All fluids in the hydraulic system(s) shall be inspected for contamination and proper type and shall be maintained at the level recommended by the manufacturer.

Chapter 13 Inspection and Maintenance of Line Voltage Electrical Systems

13.1 General. If the apparatus has a line voltage electrical system, it shall be inspected and maintained in accordance with this chapter.

13.2 Power Source.

13.2.1 All components of the line voltage power source shall be maintained in accordance with the recommendations of the manufacturer.

13.2.2 All power sources shall be inspected for security of mounting, condition, and fluid leakage.

13.2.3 Power sources shall be diagnostically checked.

13.2.4 Remote controls for power sources shall be inspected for condition and shall be diagnostically checked.

13.3 Wiring. All wiring and wire looms shall be inspected for security of mounting, tight connections, proper routing, presence of grommets, condition, and cleanliness.

13.4 Appliances and Controls. All line voltage appliances and controls including, but not limited to, the following appliances and controls shall be inspected for security of mounting and condition:

- (1) Cord reels
- (2) Extension cords
- (3) Scene lights
- (4) Circuit breaker boxes
- (5) Switches
- (6) Relays
- (7) Receptacles
- (8) Inlet devices
- (9) Light towers
- (10) Other line voltage devices not otherwise specified in Section 13.4(1) through (9)

13.5 Circuit Protection.

13.5.1 Circuit breakers and ground fault circuit interrupters (GFCIs) shall be inspected for condition and diagnostically checked.

13.5.2 All circuit breakers and ground fault circuit interrupters (GFCIs) shall be cycled off and on.

13.6 Instrumentation. Instrumentation, including voltmeter(s), ammeter(s), and frequency meter(s); warning and indicator lights; and associated interlock systems, shall be inspected for condition and diagnostically checked.

13.7 Engine-Driven Generators.**13.7.1 Air-Cooled Engine-Driven Line Voltage Generator.**

13.7.1.1* All components of an air-cooled engine-driven line voltage generator shall be inspected for security of mounting, deformation, cleanliness, and leaks.

13.7.1.2 The engine shall be inspected and maintained in accordance with the following portions of this standard:

- (1) Subsections 7.4.1 through 7.4.5
- (2) Sections 7.6 through 7.8

13.7.2 Water-Cooled Engine-Driven Line Voltage Generator.

13.7.2.1 All components of a water-cooled engine-driven line voltage generator shall be inspected for security of mounting, deformation, cleanliness, and leaks.

13.7.2.2 The engine shall be inspected and maintained in accordance with the following portions of this standard:

- (1) Subsections 7.4.1 through 7.4.5
- (2) Subsections 7.5.1 through 7.5.9
- (3) Sections 7.6 through 7.8

13.8 Power Takeoff (PTO)–Driven Line Voltage Generators.

13.8.1 All components of PTO-driven line voltage generators including, but not limited to, the following shall be inspected for security of mounting, deformation, and leaks:

- (1) PTO
- (2) Drive shafts
- (3) Transfer case
- (4) Gear box
- (5) Generator

13.8.2 All fluids in the PTO system(s) shall be visually inspected for contamination and shall be maintained at the level recommended by the manufacturer.

13.9 Hydraulic-Driven Line Voltage Generators.

13.9.1 All components of hydraulic-driven line voltage generators including, but not limited to, the following shall be inspected for security of mounting, deformation, and leaks:

- (1) Hydraulic pump and drive system
- (2) Hydraulic motor and drive system
- (3) Hydraulic fluid reservoir
- (4) Hydraulic fluid cooler
- (5) Control systems
- (6) Hose, lines, and valves

13.9.2 All fluids in the hydraulic system(s) shall be visually inspected for contamination and proper type and shall be maintained at the level recommended by the manufacturer.

13.10 Belt-Driven Line Voltage Generators. All components of belt-driven line voltage generators including, but not limited to, the following shall be inspected for security of mounting and deformation:

- (1) Belts
- (2) Pulleys
- (3) Clutch and control system
- (4) Electronics
- (5) Generator
- (6) Mounting hardware

Chapter 14 Inspection and Maintenance of Utility Air and Breathing Air Systems

14.1 General. Any compressed air system on a fire apparatus, whether for breathing or utility air, shall be inspected and maintained in accordance with this chapter.

14.1.1 If the apparatus has a breathing air compressor system, the compressor system shall be serviced annually by a manufacturer's authorized representative.

14.1.2 If the apparatus has a breathing air compressor system, the quality of air produced by the breathing air compressor system shall be tested in accordance with NFPA 1989 following completion of the annual servicing required by 14.1.1.

14.2 System Components.

14.2.1 All components of the air system shall be maintained in accordance with the recommendations of the assembler or manufacturer.

14.2.2 All thermal insulating material around air system components shall be inspected for security of mounting and condition.

14.2.3 If the air system has drive belts, they shall be inspected for proper adjustment.

14.2.4 Automatic shutdown systems shall be tested in accordance with the recommendations of the assembler or manufacturer.

14.2.5 All system components shall be diagnostically checked for leaks, operation, and pressure settings.

14.3 Labels. All warning, function, and instruction labels shall be inspected for condition and legibility.

14.4 Piping, Hose, Valves, and Instrumentation.

14.4.1 All rigid piping shall be inspected for security of mounting and deformation.

14.4.2 All flexible hose shall be inspected for cuts, abrasions, or damage.

14.4.3 All valves, quick couplers, and hose reels shall be inspected for security of mounting, proper operation, and leakage.

14.4.4 All gauges, instruments, and regulators shall be inspected for security of mounting and condition.

14.5 Air Compressors.

14.5.1 Compressors and boosters shall be inspected for security of mounting and diagnostically checked.

14.5.2 Air-intake filters and screens shall be inspected for security of mounting and airflow obstruction or restriction.

14.5.3 The compressor cooling system shall be inspected for cleanliness and diagnostically checked.

14.6 Purification System.

14.6.1 The purification system shall be inspected for security of mounting and deformation, shall be tested for leakage, and shall be diagnostically checked.

14.6.2 Filter elements and purifier cartridges shall be replaced when specified by the manufacturer.

14.7 Air Storage Tanks.

14.7.1 Air storage tanks shall be inspected for security of mounting and shall be tested for leakage.

14.7.2 Air storage tanks shall be inspected to verify that hydrostatic test dates are within the periods specified by the manufacturers and the applicable governmental agencies.

14.8* Refill Stations. Fragmentation tubes, guards, or any other safety devices associated with SCBA filling stations shall be inspected for security of mounting, deformation, and condition.

14.9 Air Compressor.

14.9.1 Air-Cooled Engine-Driven Air Compressor.

14.9.1.1* All components of an air-cooled engine-driven air compressor shall be inspected for security of mounting, deformation, cleanliness, and leaks.

14.9.1.2 The air compressor shall be diagnostically checked as recommended by the manufacturer.

14.9.1.3 The engine shall be inspected and maintained in accordance with the following portions of this standard:

- (1) Subsections 7.4.1 through 7.4.5
- (2) Sections 7.6 through 7.8

14.9.2 Water-Cooled Engine-Driven Air Compressor.

14.9.2.1 All components of a water-cooled engine-driven air compressor shall be inspected for security of mounting, deformation, cleanliness, and leaks.

14.9.2.2 The air compressor shall be diagnostically checked as recommended by the manufacturer.

14.9.2.3 The engine shall be inspected and maintained in accordance with the following portions of this standard:

- (1) Subsections 7.4.1 through 7.4.5
- (2) Subsections 7.5.1 through 7.5.9
- (3) Sections 7.6 through 7.8

14.9.3 Power Takeoff (PTO)–Driven Air Compressor.

14.9.3.1 All components of a PTO-driven air compressor including, but not limited to, the following shall be inspected for security of mounting, deformation, and leaks and shall be diagnostically checked as recommended by the manufacturer:

- (1) PTO
- (2) Drive shafts
- (3) Transfer case
- (4) Gear box
- (5) Air compressor

14.9.3.2 All fluids in the PTO system(s) shall be inspected for contamination and shall be maintained at the level recommended by the manufacturer.

14.9.4 Hydraulic-Driven Air Compressor.

14.9.4.1 All components of a hydraulic-driven air compressor including, but not limited to, the following shall be inspected for security of mounting, deformation, and leaks and shall be diagnostically checked as recommended by the manufacturer:

- (1) Hydraulic pump
- (2) Hydraulic motor
- (3) Hydraulic fluid reservoir
- (4) Hydraulic fluid cooler
- (5) Control systems
- (6) Hose, lines, and valves

14.9.4.2 All fluids in the hydraulic system(s) shall be inspected for contamination and proper type and shall be maintained at the level recommended by the manufacturer.

14.10 Records.

14.10.1 Complete records shall be maintained of all inspections and maintenance performed on the compressed air system.

14.10.2 If the system is a breathing air compressor system, records of air quality testing, as required by NFPA 1989, shall be examined to determine that the air is being tested at the proper intervals and that no indications of deteriorating air quality exist.

Chapter 15 Inspection and Maintenance of Winch Systems

15.1 General. Any winch or winch attachment point on a fire apparatus shall be inspected and maintained in accordance with this chapter.

15.2 Winch Assembly. The winch assembly shall be cleaned, shall be inspected for security of mounting, shall be diagnostically checked, and shall be lubricated.

15.3 Winch Wire or Synthetic Rope.

15.3.1 The winch wire or synthetic rope shall be unwound from the winch drum and checked for security of attachment to the drum, security of attachment at the clevis and hook, kinks in the wire or rope, and frayed strands.

15.3.2 Wire rope shall be cleaned and lubricated in accordance with the manufacturer's instructions.

15.3.3 All rollers and guides shall be inspected for proper lubrication, proper operation, and any signs of wear.

15.4 Power Supply and Controls.

15.4.1 Power supply cables, remote control cables, and hydraulic hose shall be checked for wear, cracking, kinking, and abrasion.

15.4.2 The controls shall be diagnostically checked to ensure that they allow forward, reverse, neutral, and free-spooling clutch operation.

15.4.3 Hydraulic fluid and filters shall be maintained in accordance with the manufacturer's recommendations.

15.4.4 If present, the "OK to operate winch" indicator and the interlock system to prevent advancement of the engine speed shall be diagnostically checked.

15.5 Attachment Points. Attachment points for removable electric winches shall be inspected for security of mounting and damage.

Chapter 16 Road Tests and Annual Weight Verification

16.1 General. The chassis components shall be tested annually as required by this chapter.

16.2 Fire Apparatus Axle Weight Test.

16.2.1 The fully loaded fire apparatus shall be weighed following the procedure specified in 16.2.2 through 16.2.5 to ensure that the weight on the front and rear axles and the gross vehicle weight do not exceed the gross axle weight ratings (GAWRs) and the gross vehicle weight rating (GVWR) or gross combination weight rating (GCWR) as shown on the rating plate on the fire apparatus.

16.2.2 The fire apparatus shall be prepared to be weighed as follows:

- (1) Load the apparatus with all items that are onboard while it is in service.
- (2) Fill all fluid tanks, including the following:
 - (a) Fuel tank
 - (b) Foam tank(s)
 - (c) Water tank
 - (d) Drinking water coolers
 - (e) Ice chests
 - (f) Portable equipment fuel containers
- (3) Remove all personnel from the driving and crew compartments.

16.2.3* The fire apparatus shall be weighed using a certified truck scale as follows:

- (1) Weigh the front axle.
- (2) Weigh the rear axle, whether single or tandem.
- (3) Weigh the entire apparatus.

16.2.4 The apparatus weight form shown in Figure 16.2.4 shall be completed as follows to determine if the apparatus is overloaded:

- (1) Record the axle weight ratings shown on the rating plate of the apparatus on line A.
- (2) Record the weight data obtained when the apparatus is weighed, as required by 16.2.3, on line B.
- (3)*Determine the personnel allowance by multiplying the number of riding positions in the driving and crew compartment by 200 lb (90 kg) and record that value on line C.
- (4)*Determine other weight that might be added, including any items normally on the fire apparatus when it is in service but missing during the weighing, such as personal clothing, and additional equipment that might be carried during response to certain incidents, and enter those values on line D.
- (5) Add lines B, C, and D for each column and record the value on line E.
- (6) Subtract line E from line A and record the value on line F.

16.2.5 If all of the reserve capacity values (line F of Figure 16.2.4) are not positive, equipment on the apparatus shall be removed or redistributed as necessary and the apparatus reweighed until all reserve values are positive.

16.3 Braking System.

16.3.1 Testing of the braking system, including antilock brake systems and auxiliary brake systems, shall be conducted at least annually and whenever adjustments, repairs, or modifications have been performed on any component that can affect the proper operation of the braking system or systems.

16.3.2 All testing shall be conducted at a location and in a manner that does not violate local, state, provincial, or federal traffic laws.

16.3.3* The braking system test procedure shall be as follows:

- (1) Lay out a course that is 12 ft (3.7 m) wide with a start and stop line, with the stop line showing the stopping distance for the type of vehicle. (See Table 16.3.3.)
- (2) Approach the start line with the vehicle being tested centered in the course and traveling at a speed of 20 mph (32 km/hr).
- (3) Apply the service brake firmly as the vehicle's front bumper crosses the start line.
- (4) Observe whether the vehicle comes to a smooth stop within the prescribed distance without pulling to the right or left beyond limits.

16.3.4 The vehicle stopping distance shall be not greater than that given in Table 16.3.3, and the vehicle shall not pull to the left or right across the sides of the course boundaries.

16.4 Parking Brake System.

16.4.1* The parking brake system shall be tested at least annually.

16.4.2* The parking brake system shall hold the fully loaded fire apparatus on a grade of 20 percent or the steepest grade in the fire department's jurisdiction if a grade of 20 percent is not available.



	Front Axle	Rear Axle	Tiller Axle	Total Vehicle
A. GAWR				
B. Recorded weight				
C. Personnel allowance				
D. Other adjustments				
E. Total of rows B, C, and D				
F. Reserve capacity (row A minus row E)				

FIGURE 16.2.4 Apparatus Weight Form.

Table 16.3.3 Stopping Distances

Gross Vehicle Weight Rating	ft	m
10,000 lb (4,540 kg) or less	25	7.5
Single-unit vehicles over 10,000 lb (4,540 kg), except truck tractor	35	10.5
Combination vehicles and truck tractors over 10,000 lb (4,540 kg)	40	12.0

16.4.3 The parking brake shall be tested with the apparatus stopped while facing uphill and again while facing downhill on the same grade.

16.5 Road Test.

16.5.1 A road test of the fire apparatus shall be conducted at least annually, after each scheduled maintenance interval, and after repair, adjustment, or modification of the engine, transmission, drivetrain, suspension, brakes, or steering.

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

16.5.3 The engine shall not be operated in excess of the maximum governed speed.

16.5.4 The test shall consist of the following:

- (1) Attaining a minimum top speed of not less than 50 mph (80 km/hr)
- (2) Observing and recording the following while driving at least 1 mile at a safe speed for the conditions and making turns of 90 degrees to both the left and right:
 - (a) Improper transmission shifting
 - (b) Driveline and vehicle vibrations
 - (c) Drifting and pulling during acceleration or braking
 - (d) Abnormal noise
 - (e) Resistance to steering recovery after a 90-degree turn

Chapter 17 Performance Testing of Low-Voltage Electrical Systems

17.1 General. The major components of the low-voltage electrical systems shall be tested as required by this chapter.

17.2* Frequency. Performance tests shall be conducted at least annually and whenever major repairs or modifications to the low-voltage electrical system or any component of the system have been made.

17.3 Battery Test.

17.3.1 Inspection. Before testing, the batteries shall be carefully inspected.

17.3.1.1 The batteries shall be cleaned of any accumulated dirt or corrosion, and the connections shall be checked to ensure that they are clean and tight.

17.3.1.2 The batteries shall be inspected for cracks, swelling, deformation, or other physical defects.

17.3.1.3 Batteries that are not sealed shall be checked to verify that the cells have the proper electrolyte level, and distilled water shall be added if necessary.

17.3.1.4 Batteries that are sealed shall be inspected to verify that any electrolyte level indicator indicates sufficient electrolyte.

17.3.2 Battery Test Procedure. Each battery shall be individually tested using either the procedure specified in 17.3.2.1 or the procedure specified in 17.3.2.2.

17.3.2.1* Conductivity Testing. The following procedure shall be used to test the batteries if an electronic battery conductance tester is used:

- (1) If the battery terminal voltage is below 12.4 volts for a 12-volt battery, or 6.2 volts for a 6-volt battery, fully charge the battery before proceeding.
- (2) Turn off the fire apparatus and remove any charger.
- (3) Disconnect all battery cables from the battery to be tested.
- (4) Connect the tester to the battery to be tested, making the connection to the lead pad of the battery post or terminal and not to a battery cable.
- (5) Perform the test in accordance with the instructions provided by the tester manufacturer.
- (6) Record the cold cranking amperage (CCA) value reported in the apparatus maintenance records for trend analysis.
- (7) If the measured CCA of the battery is less than 80 percent of the original CCA rating of the battery, the battery has failed.

17.3.2.2 Load Testing.

17.3.2.2.1 General. The following procedure shall be used to test the batteries if a battery load tester is used instead of an electronic battery conductance tester:

- (1) If the battery terminal voltage is below 12.6 volts for a 12-volt battery or 6.3 volts for a 6-volt battery, fully charge the battery before proceeding.
- (2) Turn off the fire apparatus and remove any charger.
- (3) Disconnect all battery cables from the battery to be tested.
- (4) Connect a load tester to the battery to be tested.
- (5) Connect a digital voltmeter that has a ± 0.5 percent dc voltage accuracy or better if the load tester has no dc voltage meter.
- (6) Adjust the current load of the load tester to one-half the CCA rating for the battery being tested.
- (7) Measure and record the temperature of the battery.
- (8) Apply the load for 15 seconds.
- (9) Record the battery terminal voltage at the end of 15 seconds.
- (10) Discontinue the load test.
- (11) If the voltage is below the value shown in Table 17.3.2.2.1, the battery has failed.

Table 17.3.2.2.1 Voltage for Battery to Pass Load Test

Battery Temperature		Voltage (V)	
°F	°C	12-Volt Battery	6-Volt Battery
80	27	9.70	4.85
70	21	9.60	4.80
60	16	9.50	4.75
50	10	9.40	4.70
40	4	9.30	4.65
30	-1	9.10	4.55
20	-6	8.90	4.45
10	-12	8.70	4.35
0	-18	8.50	4.25

17.3.2.2.2 Battery Failure.

17.3.2.2.2.1 If the battery fails, the load shall be removed and the terminal voltage observed for 15 minutes.

17.3.2.2.2.2 If the voltage fails to reach 12.45 volts for a 12-volt battery or 6.23 volts for a 6-volt battery, the battery shall be fully recharged and the test repeated once.

17.3.2.2.2.3 If the voltage does reach 12.45 volts for a 12-volt battery or 6.23 volts for a 6-volt battery, the battery has failed.

17.4* Starter Wiring Test.

17.4.1 The wiring from the battery to the starter shall be inspected for corrosion, loose connections, worn insulation, or potential chafing points.

17.4.2 The maximum voltage drop between the points defined in 17.4.2.1 and 17.4.2.2 shall be measured while the engine is cranking.

17.4.2.1 The voltage drop in the positive (+) starter wiring shall be measured between the positive (+) input post on the

starter (not the wire or connector) and the positive (+) battery terminal (not the wire or connector).

17.4.2.2 The voltage drop in the ground (-) starter wiring shall be measured between the case of the starter (not the engine block or frame) and the negative (-) battery terminal (not the wire or connector).

17.4.3 The voltage drop in each side of the wiring shall not exceed 0.2 volts for a 12-volt nominal system or 0.4 volts for a 24-volt nominal system.

17.5* Alternator Test.

17.5.1 One or more digital voltmeters with a ± 0.5 percent or better dc voltage accuracy and an ammeter capable of measuring the full output of the alternator with a ± 3 percent or better dc current accuracy shall be used for the alternator test.

17.5.2 Alternator output shall be measured between the alternator output post and the battery as specified in 17.5.2.1 and 17.5.2.2.

17.5.2.1 The alternator's positive (+) lead voltage drop shall be measured from the positive (+) output post of the alternator (not the wire or connector) to the positive (+) battery terminal (not the wire or connector).

17.5.2.2 The alternator's negative (-) lead voltage drop shall be measured from the alternator case or the negative (-) output post of the alternator (not the wire or connector) to the negative (-) battery terminal (not the wire or connector).

17.5.3 The meters shall be permitted to be connected before or after starting the engine.

17.5.4 The measurement point shall be selected such that any current to loads from the alternator, but not from the battery, are included in the measurement.

17.5.5* The alternator shall be tested as follows:

- (1) Start the test with the engine temperature below 100°F (38°C).
- (2) Increase the engine speed to 75 percent of maximum (governed) engine speed.
- (3) Turn on enough electrical loads on the apparatus for the total draw to exceed the alternator output, adding load at the battery, if necessary.
- (4) Record the maximum alternator current and the voltage drop in the positive (+) and negative (-) alternator leads.
- (5) Stop the test and turn off loads.
- (6) If the alternator output current does not reach at least 80 percent of its nameplate rated output current, the test has failed.
- (7)*If the voltage drop exceeds 0.2 volts for a 12-volt nominal system or 0.4 volts for a 24-volt nominal system in either alternator lead, the test has failed.

17.6 Regulator Test.

17.6.1 The regulator test shall be performed with the battery fully charged.

17.6.2 The voltage shall be measured at the battery terminals.

17.6.3 The temperature of the regulator shall be measured and recorded.

17.6.4 The alternator output shall be measured at a point between the alternator output post and the battery, with the measurement point selected such that any current to loads from the alternator, but not from the battery, is included in the measurement.



17.6.5 The regulator shall be tested twice.

17.6.5.1 The first test shall be run with all loads that can be turned off and the engine at idle speed.

17.6.5.2 The second test shall be run with sufficient loads turned on that the alternator is producing a minimum of one-half of its rated output and the engine running at one-half of maximum (governed) speed.

17.6.6* If the voltage at the battery is not within the range listed in Table 17.6.6, the test has failed.

Table 17.6.6 Voltage Range for Battery to Pass Regulator Test

Regulator Temperature		Voltage (V)		
°F	°C	12-Volt Nominal System	24-Volt Nominal System	42-Volt Nominal System
200	93	13.6–14.2	27.2–28.4	40.8–42.6
150	66	13.7–14.3	27.4–28.6	41.1–42.9
100	38	13.8–14.4	27.6–28.8	41.4–43.2
50	10	14.0–14.9	28.0–29.8	42.0–44.7
0	–18	14.2–15.5	28.4–31.0	42.6–46.5

17.7 Battery Charger/Conditioner Test.

17.7.1 If the apparatus is equipped with a battery charger or conditioner, it shall be tested as described in 17.7.2 and 17.7.3.

17.7.2 With the apparatus turned off, and electrical loads that exceed the rated output of the charger/conditioner turned on, the output of the battery charger/conditioner shall be at least 80 percent of the rated output of the battery charger/conditioner.

17.7.3 With the battery fully charged, the float voltage of the battery charger/conditioner shall not drop to less than 13.8 volts for a 12-volt nominal system, 27.6 volts for a 24-volt nominal system, or 41.4 volts for a 42-volt nominal system.

17.8* Total Continuous Electrical Load Test.

17.8.1 The total continuous electrical load test shall be permitted to be conducted simultaneously with other electrical or pumping tests.

17.8.2 The voltage measurements for this test shall be made with a voltmeter with a resolution of 0.01 volts or better.

17.8.3 The following test procedure shall be used:

- (1) Advance the engine speed to at least 50 percent of the governed speed of the engine.
- (2)*Turn on all loads that comprise the total continuous electrical load, except loads associated with the following:
 - (a) Aerial hydraulic pump
 - (b) Foam pump
 - (c) Hydraulic-driven equipment
 - (d) Winch
 - (e) Windshield wipers
 - (f) Four-way hazard flashers
 - (g) Compressed air foam system (CAFS) compressor

(3) Measure the battery voltage at the battery terminals.

(4) Operate the apparatus under the conditions specified in 17.8.3(1) through (3) continuously for at least 20 minutes, with load shedding permitted by the system if the apparatus is equipped with an automatic electrical load management system.

(5) Measure the battery voltage at the battery terminals.

(6) Turn off electrical loads and reduce engine speed, unless required for other simultaneous testing.

17.8.4* If the voltage drop exceeds 0.05 volts from the beginning to the end of the test, the test shall be considered a failure.

17.9 Solenoid and Relay Test.

17.9.1 The solenoid and relay test shall be performed on all relays and solenoids that control the power to motors, or total loads of 50 amperes or more, including the following:

- (1) Starter motor
- (2) Primer motor
- (3) Aerial emergency power source
- (4) Cab tilt hydraulic pump
- (5) Hydraulic or electric ladder or equipment racks
- (6) Battery or master load disconnects
- (7) Mechanical siren

17.9.2 The solenoid or relay shall be tested as follows:

- (1) Attach a voltmeter from the input power stud to the point between the contacts and the motor or load.
- (2) Activate the load.
- (3) Measure the voltage across the power connections.
- (4) Restore any insulation disturbed by the performance of the test.

17.9.3* If the voltage drop exceeds 0.3 volts, the test has failed.

Chapter 18 Performance Testing of Fire Pumps and Industrial Supply Pumps

18.1* General. If the fire apparatus is equipped with a fire pump or an industrial supply pump, the pump shall be inspected and tested as required by this chapter.

18.2* Frequency. Performance tests shall be conducted at least annually and whenever major repairs or modifications to the pump or any component of the apparatus that is used in pump operations have been made.

18.3 Test Site.

18.3.1* Test Site from Draft. The test site shall be adjacent to a supply of clear water, with the water level such that the lift from the surface of the water to the center of the pump intake connection is not greater than the maximum lift shown in Table 18.5.1.1.1(a) and is close enough to allow the suction strainer to be submerged at least 2 ft (0.6 m) below the surface of the water.

18.3.2* Test Site from Hydrant. The site shall provide an area for stationing the apparatus, a hydrant(s) capable of flowing the rated capacity of the pump, and an adjacent area where the water can be discharged.

18.4* Environmental Conditions. Tests shall be performed when the environmental conditions are within the limits shown in Table 18.4.

Table 18.4 Environmental Conditions for Testing Pumps

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

18.5 Equipment.

18.5.1 Suction or Intake Hose.

18.5.1.1* Suction Hose and Strainer from Draft. When a pump is tested from draft at elevations up to 2000 ft (610 m), the suction hose arrangement shall be as specified in 18.5.1.1.1 or 18.5.1.1.2, as appropriate.

18.5.1.1.1 Pumps Rated in Gallons per Minute. If the pump was originally rated in gallons per minute at pressures measured in pounds per square inch, the following shall be used:

- (1) Suction hose of the appropriate size for the rated capacity of the pump as shown in Table 18.5.1.1.1(a)
- (2) A suction strainer and hose that will allow flow with total friction and entrance loss not greater than that specified in Table 18.5.1.1.1(b) through Table 18.5.1.1.1(e)

Table 18.5.1.1.1(a) Suction Hose Size, Number of Suction Lines, and Lift for Fire Pump

Rated Capacity		Maximum Suction Hose Size		Maximum Number of Suction Lines*	Maximum Lift	
gpm	L/min	in.	mm		ft	m
250	1,000	3	75	1	10	3
300	1,100	3	75	1	10	3
350	1,300	4	100	1	10	3
500	2,000	4	100	1	10	3
750	3,000	4½	110	1	10	3
1000	4,000	6	150	1	10	3
1250	5,000	6	150	1	10	3
1500	6,000	6	150	2	10	3
1750	7,000	6	150	2	8	2.4
2000	8,000	6	150	2	6	1.8
2000	8,000	8	200	1	6	1.8
2250	9,000	6	150	3	6	1.8
2250	9,000	8	200	1	6	1.8
2500	10,000	6	150	3	6	1.8
2500	10,000	8	200	1	6	1.8
3000	12,000	6	150	4	6	1.8
3000	12,000	8	200	2	6	1.8
3500	14,000	6	150	4	6	1.8
3500	14,000	8	200	2	6	1.8
4000	16,000	6	150	4	6	1.8
4000	16,000	8	200	2	6	1.8
4500	18,000	6	150	4	6	1.8
4500	18,000	8	200	2	6	1.8
5000	20,000	6	150	4	6	1.8
5000	20,000	8	200	2	6	1.8

*Where more than one suction line is used, all suction lines are not required to be the same hose size.

Table 18.5.1.1.1(b) Friction and Entrance Loss in 20 Feet of Suction Hose, Including Strainer (Inch-Pound Units)

Flow Rate (gpm)	Suction Hose Size (Inside Diameter)							
	One 3 in.		One 3½ in.		One 4 in.		One 4½ in.	
	ft Water	in. Hg	ft Water	in. Hg	ft Water	in. Hg	ft Water	in. Hg
250	5.2(1.2)	4.6						
175	2.6(0.6)	2.3						
125	1.4(0.3)	1.2						
300	7.5(1.7)	6.6	3.5(0.8)	3.1				
210	3.8(0.8)	3.4	1.8(0.4)	1.6				
150	1.9(0.4)	1.7	0.9(0.2)	0.8				
350			4.8(1.1)	4.2	2.5(0.7)	2.1		
245			2.4(0.5)	2.1	1.2(0.3)	1.1		
175			1.2(0.3)	1.1	0.7(0.1)	0.6		
500					5.0(1.3)	4.4	3.6(0.8)	3.2
350					2.5(0.7)	2.1	1.8(0.4)	1.6
250					1.3(0.4)	1.1	0.9(0.3)	0.8
750					11.4(2.9)	9.8	8.0(1.6)	7.1
525					5.5(1.5)	4.9	3.9(0.8)	3.4
375					2.8(0.7)	2.5	2.0(0.4)	1.8

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

Table 18.5.1.1.1(c) Friction and Entrance Loss in 20 Feet of Suction Hose, Including Strainer (Inch-Pound Units)

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

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