Chapter 1 Administration

1.1* Scope. This standard shall define the minimum requirements for the design, performance, and testing of new automotive ambulances used for out-of-hospital medical care and patient transport.

1.2 Purpose. The purpose of this standard shall be to establish the minimum requirements for new automotive ambulances that are safe and reliable when properly maintained and used within their design parameters.

1.3 Application.

1.3.1 This standard shall apply to new ambulances that are contracted for on or after January 1, 2013.

1.3.2 This standard shall not apply to the following:

(1) Refurbished and re-mounted vehicles

(2) Vehicles that are used for transport of more than two stretcher-bound patients at the same time

(3) Mass casualty vehicles

(4) Military field ambulances

(5) Vehicles intended for use as fire apparatus as specified in NFPA 1901 or NFPA 1906

(6) Wheeled chair transport vehicles

1.4* Retroactivity. This standard shall not be applied retroactively.

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

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

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

1.6* Units and Formulas.

1.6.1 In this standard, values for measurement in U.S. customary units shall be followed by equivalents in SI units.

1.6.2 Either set of values can be used, but the same set of values (either U.S. customary units or SI units) shall be used consistently.

Chapter 2 Referenced Publications

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


2.3 Other Publications.


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


2.3.4 ECE Publications. UN Economic Commission for Europe, Palais des Nations, CH-1211 Geneva 10, Switzerland.

ECE R29, Uniform Provisions Concerning the Approval of Vehicles with Regard to the Protection of the Occupants of the Cab of a Commercial Vehicle.

2.3.5 IPC Publications.

IPC A-610D, “Acceptability of Electronic Assemblies.”

2.3.6 ISO Publications. International Organization for Standardization, 1 Ch. de la Vioz-Creuse, Case postale 56, CH-1211 Geneva 20, Switzerland, www.iso.ch.net.

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

ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories, 2005.


SAE J551/1, Performance Levels and Methods of Measurement of Electromagnetic Compatibility of Vehicles, Boats (up to 15 m), and Machines (16.6 Hz to 18 GHz), 2006.


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

SAE J575, Test Methods and Equipment for Lighting Devices and Components for Use on Vehicles Less Than 2032 mm in Overall Width, 2007.


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


SAE J1127, Low Voltage Battery Cable, 2005.

SAE J1128, Low Voltage Primary Cable, 2005.

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


SAE J1690, Flashers, 1996.


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 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

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

3.2.7 Standard. A document, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

3.3.1 Acceptance. An agreement between the purchasing authority and the contractor that the terms and conditions of the contract have been met.

3.3.2 Acceptance Tests. Tests performed on behalf of or by the purchaser at the time of delivery to determine compliance with the specifications for the ambulance.

3.3.3 Ambulance. A vehicle used for emergency medical care that provides a driver’s compartment; a patient compartment to accommodate an emergency medical services provider (EMSP) and one patient located on the primary cot so positioned that the primary patient can be given emergency care during transit; equipment and supplies for emergency care at the scene as well as during transport; safety, comfort, and avoidance of aggravation of the patient’s injury or illness; two-way radio communication; and audible and visual traffic warning devices.

3.3.3.1* Substantially Similar Ambulance. An ambulance in which the relevant area or component that is being compared or considered is comparable. Applicable to the test being considered for an ambulance in which like areas are compared.

3.3.3.2 Type I Ambulance. An ambulance with a 10,001 lb to 14,000 lb GVWR constructed on a cab chassis with a modular ambulance body.

3.3.3.3 Type I-AD (Additional Duty) Ambulance. An ambulance with a 14,001 lb or more GVWR constructed on a cab chassis with a modular ambulance body.

3.3.4 Type II Ambulance. An ambulance constructed on a van.

3.3.5 Type III Ambulance. An ambulance with a 10,001 lb to 14,000 lb GVWR constructed on a cutaway van chassis with integrated modular ambulance body.

3.3.6 Type III-AD (Additional Duty) Ambulance. An ambulance with a 14,001 lb or more GVWR constructed on a cutaway van chassis with integrated modular body.

3.3.7 Bulkhead. The partition dividing the driver compartment from the patient compartment.

3.4 Angle.  

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

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

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

3.5 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 ambulance’s batteries.

3.6 Bonded (Bonding). Connected to establish electrical continuity and conductivity.

3.7 Bulkhead. The partition dividing the driver compartment from the patient compartment.
3.3.8 Center of Gravity. The point at which the entire weight of the ambulance is considered to be concentrated so that, if supported at this point, the ambulance would remain in equilibrium in any position.

3.3.9 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 cowling).

3.3.10 Compartment.

3.3.10.1 Enclosed Compartment. A weather-resistant area designed to protect stored items from environmental damage that is confined on six sides and equipped with an access opening(s) that can be closed and latched.

3.3.10.2 Patient Compartment. The portion of the ambulance behind the cab.

3.3.10.2.1 Type I Patient Compartment. The modular body area added on behind the cab.

3.3.10.2.2 Type II Patient Compartment. The body area beginning immediately behind the forward bulkhead.

3.3.10.2.3 Type III Patient Compartment. The modular body area added on behind the cab.

3.3.11 Conductor.

3.3.11.1 Grounding Conductor. A non-current-carrying conductor used to connect equipment or the ground circuit of a wiring system to the power source grounding system.

3.3.11.2 Line Voltage Conductor. An ungrounded current-carrying conductor of a line voltage circuit.

3.3.11.3 Neutral Conductor. The conductor connected to the neutral point of a system that is intended to carry current under normal conditions.

3.3.12 Continuous Duty. Operation at a substantially constant load for an indefinitely long time.

3.3.13* Contractor. The person or company responsible for fulfilling an agreed upon contract.

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

3.3.15 Documentation. Any data or information supplied by the manufacturer or contractor relative to the ambulance, including information on its operation, service, and maintenance.

3.3.16 Electrical Appliance. An electrical device or instrument designed to perform a specific function, such as scene lights, battery charger, medical equipment, and so forth.

3.3.17* Electronic Siren. An audible warning device that produces sound electronically through the use of amplifiers and electromagnetic speakers.

3.3.18 Exterior. A nonsheltered location exposed to the environment, either continuously or intermittently.

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

3.3.20 Fixed Power Source. Any line voltage power source except a portable generator.

3.3.21 Fully Latched Position. The last or fully closed position on the striker of a FMVSS 206 compliant door latch.

3.3.22 Gallon. United States gallon.

3.3.23 Gauge. A visual device that indicates a measurement.

3.3.24 GAWR. See 3.3.66.1, Gross Axle Weight Rating.

3.3.25 Generator. An electromechanical device for the production of electricity.

3.3.26* Grade. A measurement of the angle used in road design and expressed as a percentage of elevation change over distance.

3.3.27 Ground Clearance. The clearance under a vehicle at all locations except the axles and driveshaf connections to the axle or item designed to swing clear.

3.3.28 GVWR. See 3.3.66.3, Gross Vehicle Weight Rating (GVWR).

3.3.29 High-Idle Speed Control. A control or switch system that provides a means to increase the engine operating speed from an idle condition to a higher preset operating speed. [1901, 2009]

3.3.30 Instruction Plate. A visual indication whether in pictorial or word format that provides instruction to the operator in the use of a component on the ambulance.

3.3.31 Interior. A sheltered location not exposed to the environment.

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

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

3.3.34 Latch. A mechanical device used to position the door in a closed position relative to the body framework with provision for controlled release or operation.

3.3.35 Line Voltage Circuit, Equipment, or System. An ac or dc electrical circuit, equipment, or system where the voltage to ground or from line to line is equal to or greater than 30 volts rms (ac), 42.4 volts peak (ac), or 60 volts dc.

3.3.36 Load Distribution Plan. A drawing or spreadsheet of shelves, cabinets, drawers, compartment, or otherwise storage with a maximum weight attached to each location.

3.3.37* Loose Equipment. Equipment other than the occupants and the cot that is intended to be stored on the ambulance.

3.3.38 Low Voltage Circuit, Equipment, or System. An electrical circuit, equipment, or system where the voltage does not exceed 30 volts rms (ac), 42.4 volts peak (ac), or 60 volts dc; usually 12 volts dc in an ambulance.

3.3.39 Manufacturer. The person or persons, company, firm, corporation, partnership, or other organization responsible for turning raw materials or components into a finished product.

3.3.40 Optical Center. The point specified by the optical warning device manufacturer of highest intensity when measuring the output of an optical warning device.

3.3.41 Optical Power. A unit of measure designated as candle-seconds/minute that combines the flash energy and flash rate of an optical source into one power measurement representing the true visual effectiveness of the emitted light.

3.3.42* Optical Source. Any single, independently mounted, light-emitting component in a lighting system.

3.3.43 Optical Warning Device. A manufactured assembly of one or more optical sources.

3.3.44 Panelboard. A single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall, partition, or other support; and accessible only from the front. [70, 2011]

3.3.45 Patient Cot. An elevating patient conveyance device upon which the primary patient is transported, which is also known as a transporter, gurney, and carrier.

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

3.3.47 Power Supply Assembly. Any cord or distribution assembly that is partly comprised of the neutral conductor, grounding conductor, and line voltage conductors connected from the output terminals of the power source to the first main overcurrent protection device.

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

3.3.49 psi. Pounds per square inch.

3.3.50 PTO. Power takeoff.

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

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

3.3.53 Qualified Person. A person who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, has demonstrated the ability to deal with problems relating to a particular subject matter, work, or project. [1451, 2007]
4.2.3 It shall be the responsibility of the purchaser to specify any details of the ambulance that would exceed the minimum specifications of this standard.

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

4.2.1 Responsibility for the contractor shall provide a detailed description of the ambulance, a list of equipment to be furnished, and other construction and performance details to which the ambulance shall conform.

4.2.1.1 The detailed description of the ambulance shall include, but shall not be limited to, minimum usable payload, wheelbase, curb-to-curb turning clearance radius, principal dimensions, angle of approach, and angle of departure.

4.2.1.2 The contractor’s detailed description shall include a statement specifically describing each aspect of the delivered ambulance that will not be fully compliant with the requirements of this standard.

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

4.3 Ambulance Components.

4.3.1 All components shall be installed in accordance with the manufacturer’s installation instructions or with the written approval of the component manufacturer.

4.3.2 All medical devices furnished shall comply with the U.S. Food and Drug Administration (FDA) regulatory requirements.

4.3.3 Vehicles shall be free from defects that could impair their reliability or serviceability.

4.3.4 All bodies, systems, equipment, and interfaces with the chassis not otherwise specified in this standard shall be done in accordance with the Chassis OEM Body Builders Guidelines.

4.4 Legal Requirements. The ambulance shall comply with the following:

1. Applicable federal regulations
2. State regulations as specified by the purchaser

4.6 Third-Party Certification of Test Results. Where this standard requires the witnessing or performing of tests by an independent third-party organization, that organization shall meet the requirements of this section.

4.6.1 Testing shall be witnessed or performed by an organization that is accredited for inspection of ambulances in accordance with ISO/IEC 17020, General Criteria For The Operation Of Various Types Of Bodies Performing Inspection, or accredited for testing ambulances to this standard in accordance with ISO/IEC 17025, General Requirements for the Competence of Testing and Calibration Laboratories.

4.6.2 The certification organization shall not be owned or controlled by the final stage ambulance manufacturer.

4.6.3 The certification organization shall witness all tests and shall refuse to certify any test results for a system if all components of that system requiring testing do not pass the testing required by this standard.

4.6.4 Conditional, temporary, or partial certification of test results shall not be permitted.

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

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

4.6.7 Appeal Process.

4.6.7.1 The certification organization’s operating procedures shall provide a mechanism for the manufacturer to appeal decisions.

4.6.7.2 The procedures shall include provisions for the presentation of information from representatives of both sides of a controversy to a designated appeals panel.

4.6.8 The third-party that certifies any test results shall supply the following information on the certification organization letterhead:

1. Company or business for which the results are certified
2. Date of certification
3. Ambulance model, components, or equipment being certified
4. Certification organization and address
5. Date product tested
6. Model number and specification data
4.6.9* The testing facility for each certification shall supply the following supportive verification data and information on letterhead stationery in electronic format:

(1) Name of company or business for whom product ambulance was tested
(2) Report date
(3) Name of sample product or device
(4) Contractor’s address
(5) Serial and model number(s)
(6) Specification referral and amendment number(s), and test requirement(s)
(7) Test facilities used and location
(8) Test equipment used
(9) Test procedure
(10) Test results
(11) Verifying test data
(12) Photographs
(13) Drawings
(14) Test conclusion(s)
(15) Witness(es)
(16) Authorized signature

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

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

4.7.2 Conditional, temporary, or partial certification of test results shall not be permitted.

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

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

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

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

4.7.7 Certification documentation shall be delivered with the ambulance, including results of the certification tests.

4.7.8 Certification tests performed on a substantially similar ambulance shall be valid for up to 7 years or until such time as the production product changes are so significant that they no longer meet the definition of a substantially similar ambulance.

4.8 Personnel Protection.

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

4.8.2 Electrical insulation or isolation shall be provided where necessary in order to prevent electrical shock from onboard electrical systems.

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

4.8.4 Safety-related signs shall meet the requirements of ANSI Z535.4, Product Safety Signs and Labels.

4.9 Controls and Instructions.

4.9.1 Illumination shall be provided for controls, switches, gauges, and instruments necessary for the operation of the ambulance and the equipment on it.

4.9.2* All required signs, instruction plates, and labels shall be permanent in nature, securely attached, and meet the requirements of ASTM D 5010, Standard Guide for Testing Printing Inks and Related Materials, and ANSI/UL 969, Standard for Marking and Labeling Systems.

4.9.2.1 The signs, instruction plates, and labels shall be resistant to damage from the following:

(1) Fluids to which they will normally be exposed
(2) Temperatures between -30°F and 176°F (-35°C and 80°C)
(3) Ultraviolet radiation

4.9.2.2 The exterior-mounted labels relating to safety or critical operational instructions shall be reflective or illuminated.

4.9.2.3 Controls and Switches.

4.9.2.3.1 Controls and switches that are expected to be operated by the belted driver while the ambulance is in motion shall be visible and within reach.

4.9.2.3.2 Controls and switches that are expected to be operated by the belted emergency medical service provider (EMSP) while the ambulance is in motion shall be visible and within reach of the designated primary patient care position.

4.9.2.4 Lever controls, equipment, items, and devices shall be installed, located, and stowed for the convenience of the purpose intended and shall not interfere with the EMSP or patient’s ingress or egress of respective compartments.

4.9.2.5 Marking of switches, indicators, and control devices shall be perceptively and permanently identified with at least 12-point letters for the noun or function, and 8-point letters for the remainder of the legend.

4.9.2.6 The identifications shall be contrasting colors etched or engraved in plastic or metal, or printed and laminated translucent plastic, grouped according to function, and mounted in illuminated or backlit panel(s) or the console.

4.10 Component Protection.

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

4.10.2 The types of equipment described in 4.10.1 shall be furnished with protective looms, grommets, or other devices at each point where they pass through body panels or structural members or wherever they lie against a sharp metal edge.

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

4.11* Ambulance Performance.

4.11.1 The ambulance shall meet the requirements of this standard at elevations up to 2000 ft (600 m) above sea level.

4.11.2* The ambulance shall meet all the requirements of this standard while stationary on a grade of 6 percent in any direction.

4.11.3* Where temperature requirements are not otherwise specified, the ambulance shall be designed to function in ambient temperature conditions between -20°F and 110°F (-29°C and 43°C).

4.11.3.1 All interior systems, components and permanently attached equipment shall function satisfactorily over a temperature range of 32°F to 95°F (0°C to 35°C).

4.11.3.1.1 Compliance of the equipment function shall be validated by testing a substantially similar ambulance in accordance with Section 9.11.

4.11.3.2 The ambulance and all systems, components, and equipment shall be capable of being stored at an ambient temperature between 32°F to 95°F (0°C to 35°C) without damage or deterioration.

4.11.4 The ambulance shall be capable of being driven for at least 250 mi (402 km) without refueling.

4.11.5 The vehicle shall be capable of three fordings, without water entering patient and equipment compartments while being driven through a minimum of 8 in. (203 mm) of water, at speeds of 5 mph (8 km/hr), for a distance of at least 100 ft (30 m).
4.12 Roadability.

4.12.1 The ambulance, when loaded to its GVWR shall be capable of the following performance while on dry, paved roads that are in good condition:

(1) From a standing start, the ambulance shall be able to attain a speed of 55 mph (88 km/hr) within 25 seconds on a level road.

(2) The ambulance shall be able to maintain a speed of at least 5 mph (8 km/hr) on any grade up to 35 percent.

(3) The ambulance shall be able to maintain a speed of at least 55 mph (88 km/hr) on any grade up to 3 percent.

4.12.2 The determination shall be made by actual test or original equipment manufacturer’s (OEM) certified computer prediction.

4.12.3 The maximum top speed of the ambulance shall not exceed either 77 mph (124 km/hr) or the manufacturer’s maximum service speed rating for the tires installed on the ambulance, whichever is lower.

4.12.4* The ambulance shall be capable of a sustained speed of not less than 65 mph (105 km/hr) over dry, hard surfaced, level roads, at sea level, and passing speeds of 70 mph (112 km/hr) when tested under normal ambient conditions.

4.13 Serviceability.

4.13.1 The ambulance shall be designed so that all the manufacturer’s recommended routine maintenance checks of lubricant and fluid levels can be performed by the operator without the need for hand tools.

4.13.2 Special Tools.

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

4.13.2.2 Where the purchaser is purchasing multiple ambulances under the same contract, the purchaser shall specify the number of tools required.

4.13.3 Ambulance components that interfere with repair or removal of other major components shall be attached with fasteners, such as cap screws and nuts, so that the components can be removed and installed with ordinary hand tools.

4.13.4 These components shall not be welded or otherwise permanently secured in place.

4.14 Tests on Delivery.

4.14.1 If acceptance tests are conducted at the point of delivery, they shall not be performed in a manner that requires the ambulance or a component to operate outside its designed operating range.

4.14.2 Certification from OEM and individual equipment manufacturers are acceptable providing they are not altered.

4.15* Documentation.

4.15.1 Any documentation delivered with the ambulance shall be permitted to be in printed format, electronic format, audiovisual format, or a combination thereof.

4.15.2* The ambulance manufacturer shall calculate the load distribution plan for the ambulance, and that load distribution plan be delivered with the ambulance.

4.16 Data Required of Contractor.

4.16.1 Ambulance Documentation. The contractor shall deliver with the ambulance at least one copy of the following documents:

(1) The manufacturer’s record of ambulance construction details, including the following information:

(a) Owner’s name and address
(b) Ambulance manufacturer, model, and serial number
(c) Chassis make, model, and vehicle identification number (VIN)
(d) GAWR of front and rear axles and GVWR
(e) Front tire size and total rated capacity in pounds (kilograms)
(f) Rear tire size and total rated capacity in pounds (kilograms)
(g) Type of fuel and fuel tank capacity
(h) Electrical system voltage and alternator output in amps
(i) Paint manufacturer and paint number(s)
(j) Company name and signature of responsible company representative
(k) Documents from a certified scale showing curb weight on the front axle and rear axle(s) (without personnel and equipment)
(l) Certification of compliance of the optical warning system (see 7.9.16)
(m) Siren manufacturer’s certification of the siren (see 7.10.1.1)
(n) Written load analysis and results of the electrical system performance tests (see Section 9.1 and Section 9.2)
(o) Certification of slip resistance of all exterior stepping, standing, and walking surfaces (see Section 6.12)

4.16.2 Operations and Service Documentation.

4.16.2.1 The contractor shall deliver with the ambulance at least one set of complete operation and service documentation covering the completed ambulance as delivered and accepted.

4.16.2.2 The documentation shall address at least the inspection, service, and operations of the ambulance and all major components thereof.

4.16.2.3* The contractor shall also deliver with the ambulance the following documentation for the entire ambulance and each major operating system or major component of the ambulance:

(1) Manufacturer’s name and address
(2) Country of manufacture
(3) Source for service and technical information
(4) Parts replacement information
(5) Descriptions, specifications, and ratings of the chassis
(6) Wiring diagrams for low voltage and line voltage ambulance-specific systems to include the following information:

(a) Circuit logic for all electrical components and wiring
(b) Circuit identification
(c) Connector pin identification
(d) Zone location of electrical components
(e) Safety interlocks
(f) Alternator battery power distribution circuits
(g) Input/output assignment sheets or equivalent circuit logic implemented in multiplexing systems
(h) Electrical system voltage and alternator output in amps
(i) Paint manufacturer and paint number(s)
(j) Company name and signature of responsible company representative
(k) Documents from a certified scale showing curb weight on the front axle and rear axle(s) (without personnel and equipment)
(l) Certification of compliance of the optical warning system (see 7.9.16)
(m) Siren manufacturer’s certification of the siren (see 7.10.1.1)
(n) Written load analysis and results of the electrical system performance tests (see Section 9.1 and Section 9.2)
(o) Certification of slip resistance of all exterior stepping, standing, and walking surfaces (see Section 6.12)

4.16.6 Ambulance body, chassis, and other component manufacturer’s warranties
(7) Lubrication charts
(8) Operating instructions for the chassis and any major components
(9) Instructions regarding the frequency and procedure for recommended maintenance
(10) Overall ambulance operating instructions
(11) Safety considerations
(12) Limitations of use
(13) Inspection procedures
(14) Recommended service procedures
(15) Troubleshooting guide
(16) Ambulance body, chassis, and other component manufacturer’s warranties
(17) Special data required by this standard
(18) Material safety data sheet (MSDS) for any fluid that is specified for use on the ambulance module
4.16.3 Certification and Payload Signage.

4.16.3.1* All ambulances shall have a certification and payload label as shown in Figure 4.16.3.1.

4.16.3.2 The label shall be mounted on the body (module) interior in a conspicuous location.

4.16.3.3 The complete payload calculation in Figure 4.16.3.1 shall be provided with the ambulance.

![Ambulance Data](image)

This ambulance is certified by the manufacturer to conform to the edition of NFPA 1917 Standard for Automotive Ambulance in effect on the date the ambulance as contracted for subject to any applicable statement of exception as mandated by this standard.

*Usable payload is the weight of the loose equipment, occupants, and cot as defined by NFPA 1917 Standard for Automotive Ambulances that can be carried in this ambulance without exceeding the GVWR.

FIGURE 4.16.3.1 Certification and Payload Label.

4.17 Statement of Exceptions. The entity responsible for final assembly of the ambulance shall deliver with the ambulance either a certification that the ambulance fully complies with all requirements of this standard or, alternatively, a Statement of Exceptions specifically describing each aspect of the completed ambulance that is not fully compliant with the requirements of this standard at the time of delivery.

4.17.1 The Statement of Exceptions shall contain, for each noncompliant aspect of the ambulance or missing required item, the following information:

1. A separate listing of the section(s) of the applicable standard for which compliance is lacking
2. A description of the particular aspect of the ambulance that is not in compliance therewith or required equipment that is missing
3. A description of the further changes or modifications to the delivered ambulance that must be completed to achieve full compliance
4. Identification of the entity that will be responsible for making the necessary post-delivery changes or modifications or for supplying and installing any missing required equipment to the ambulance to achieve full compliance with this standard

4.17.2 Prior to, or at the time of, delivery of the ambulance, the Statement of Exceptions shall be signed by an authorized agent of the entity responsible for final assembly of the ambulance and by an authorized agent of the purchasing entity, indicating mutual understanding and agreement between the parties regarding the substance thereof.

4.17.3 An ambulance that is delivered subject to a Statement of Exceptions other than a certification of full compliance shall not be placed in emergency service until the ambulance has been modified as necessary to accomplish full compliance with this standard.

Chapter 5 Chassis

5.1 Carrying Capacity.

5.1.1 The manufacturer shall establish the required GVWR during the design of the ambulance using the method and values specified in Table 5.1.1.

5.1.2 The manufacturer shall design the ambulance such that the completed ambulance, when loaded to its required GVWR with all loose equipment distributed as close as practical to its intended in-service configuration, does not exceed the GVWR or GAWR of the chassis.

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chassis</td>
<td></td>
</tr>
<tr>
<td>Ambulance body complete</td>
<td></td>
</tr>
<tr>
<td>Automotive fluids</td>
<td></td>
</tr>
<tr>
<td>Permanently mounted</td>
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</tr>
<tr>
<td>equipment</td>
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</tr>
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<td>Loose equipment</td>
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</tr>
<tr>
<td>Type I</td>
<td>750</td>
</tr>
<tr>
<td>Type I-AD</td>
<td>1250</td>
</tr>
<tr>
<td>(Use one of these values</td>
<td></td>
</tr>
<tr>
<td>unless the required loose</td>
<td></td>
</tr>
<tr>
<td>equipment is specified by</td>
<td></td>
</tr>
<tr>
<td>the purchaser)</td>
<td></td>
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<tr>
<td>Type II</td>
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<td>Type III</td>
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</tr>
<tr>
<td>Type III-AD</td>
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<td>Belted occupant seating</td>
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<td>positions</td>
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<tr>
<td>(No. Seats) x</td>
<td></td>
</tr>
<tr>
<td>171</td>
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<td>Cot</td>
<td></td>
</tr>
<tr>
<td>Standard cot</td>
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<tr>
<td>Power cot</td>
<td>150</td>
</tr>
<tr>
<td>Spare capacity</td>
<td>200</td>
</tr>
</tbody>
</table>

5.1.3 Minimum GVWR Required

5.1.3.1 The ambulance manufacturer shall provide a high-visibility label in a location visible to the driver while seated.

5.1.3.2* The label shall show the height of the completed ambulance in feet and inches (meters), and the GVWR in tons (metric tons).

5.2* Weight Distribution.

5.2.1 Longitudinal Weight Distribution.

5.2.1.1 When the ambulance is loaded to its GVWR, the front-to-rear weight distribution and vertical center of gravity shall be within the limits set by the chassis manufacturer.

5.2.1.2 The front GAWR shall be not less than 20 percent of the GVWR.

5.2.1.3 The rear GAWR shall be not less than 50 percent of the GVWR.

5.2.2* Lateral Weight Distribution. The vehicle, when loaded to its GVWR shall have a side-to-side tire load variation of no more than 5 percent of the total tire load for that axle.

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

5.2.4 Vehicle and component ratings shall be the manufacturer’s published ratings and shall not be modified without written authorization from the OEM.

5.2.5 The manufacturer shall design the ambulance to comply with the GAWR, the overall GVWR, and the chassis manufacturer’s load balance guidelines.

5.3 Engine and Engine System Design.

5.3.1 Cold Start Performance Requirements.

5.3.1.1 The chassis engine shall start and run for 5 minutes without stalling at 0°F (-18°C) without the use of external power or starting fluids and without the aid of engine block preheating devices (except glow plugs or combustion air pre-heater).

5.3.1.2 Compliance shall be validated by testing a substantially similar ambulance in accordance with Section 9.22.

5.3.2 Indicators shall be provided to alert the driver to high engine temperature or low oil pressure conditions.

5.3.3 An engine hourmeter shall be provided.

5.3.4 Idle reduction engine shutdown device shall be disabled if provided in accordance with federal and state exemptions.

5.4 Engine Speed Auxiliary Control Device.
5.14* Mirrors.

5.14.1 Dual side view mirrors having a combination flat and convex mirror system shall be furnished.

5.14.2 All primary side view mirrors used by the driver shall be adjustable from the driver’s position.

5.14.3 Hardware and mirror heads shall have a corrosion-resistant exterior finish.

5.10* Vehicle Stability. If the ambulance is equipped with a stability control system, the system shall have, at a minimum, a steering wheel position sensor, a vehicle yaw sensor, a lateral accelerometer, and individual wheel brake controls.

5.11 Bumpers.

5.11.1* A front bumper shall be furnished in the front of the chassis that is at least the equivalent of the chassis manufacturer’s OEM bumper.

5.11.2 The rear of the ambulance shall be furnished with a bumper that extends to within 6 in. (152 mm) of each side of the ambulance.

5.11.2.1 The rear bumper shall be secured to the vehicle’s chassis frame.

5.11.2.2 Type I and Type III vehicle’s rear bumper shall be provided with an integrated step.

5.11.2.3 The step shall be designed to prevent the accumulation of mud, ice, or snow and shall be made of anti-skid open grating material.

5.11.2.4 The step shall not be located or exposed to the interior of the ambulance when the door is closed.

5.11.2.5 The step shall be at least the width of the door opening for which it is provided.

5.11.2.6 The stepping surface shall have a minimum depth of 5 in. (127 mm) and a maximum depth of 10 in. (254 mm).

5.11.2.7 If the step protrudes more than 7 in. (178 mm) from the rear of the vehicle, a fold-up step shall be furnished.

5.11.2.8 Stepping Surface.

5.11.2.8.1 The rear stepping surface shall withstand a load of 500 lb (227 kg) with no more than 1.0 in. (25.4 mm) of deflection or 0.25 in. (6.4 mm) of permanent deformation.

5.11.2.8.2 Compliance of the rear step surface shall be validated by testing a substantially similar ambulance or bumper and step structure in accordance with Section 9.18.

5.11.2.8.3 The distance from the road surface to the top surface of the first step shall not exceed 22 in. (559 mm) with the vehicle loaded to its GVWR and/or the suspension in the kneeling condition.

5.11.2.8.4 Steps shall be provided in the door openings.

5.11.2.8.5 Step wells shall be illuminated.

5.11.2.8.6 Step surfaces shall be constructed with anti-slip material.

5.11.2.8.7* All steps shall have a minimum area of 35 in.² (22,580 mm²), and shall be of such a shape that a 5 in. (125 mm) diameter disk does not overlap any side when placed on the step.

5.12 Cab Seal.

5.12.1 If the cab and patient compartment are separate enclosures, the cab shall be provided with a sealing device.

5.12.2 The seal shall be fabricated from a material resistant to ozone, sunlight, oil, and fungus.

5.12.3 The seal shall remain flexible in temperatures between -20°F and 110°F (-29°C and 43°C).

5.12.4 The seal shall be designed for proper fit and finish and be able to absorb lateral, vertical, and torsional displacement due to body/cab movement.

5.13 Front Seats.

5.13.1 Front cab seating for the driver and at least one passenger shall be provided.

5.13.2 The driver’s seat shall have the OEM's full, unobstructed seat track travel range of longitudinal adjustment and a minimum of 30 percent of the range of inclination, but not less than the angle furnished on the OEM's standard nonreclining high back seat.

5.14* Mirrors.

5.14.1 Dual side view mirrors having a combination flat and convex mirror system shall be furnished.

5.14.2 All primary side view mirrors used by the driver shall be adjustable from the driver’s position.

5.14.3 Hardware and mirror heads shall have a corrosion-resistant exterior finish.
5.15 Cab Integrity. Cabs on ambulances with a GVWR greater than 26,000 lb (11,800 kg) shall meet the requirements of one of the following sets of standards:

1. SAE J2420, COE Frontal Strength Evaluation — Dynamic Loading Heavy Trucks, and SAE J2422, Cab Roof Strength Evaluation — Quasi-Static Loading Heavy Trucks

2. ECE Regulation number 29, Uniform Provisions Concerning the Approval of Vehicles with Regard to the Protection of the Occupants of the Cab of a Commercial Vehicle

Chapter 6 Patient Compartment

6.1 Patient Compartment Configuration. The patient compartment shall provide a minimum of 275 ft³ (7.7 m³) of space less volume for cabinets, while complying with 6.1.1 through 6.1.2.

6.1.1 A minimum of 10 in. (254 mm) shall be provided, from the nearest edge of the cot mattress to the loading door(s).

6.1.2 The compartment shall provide a minimum of 12 in. (300 mm) of clear aisle walkway on at least one side of the patient cot.

6.2 Mounting. If the body is of a modular construction, it shall be mounted per the allowed and/or recommended methods of the chassis manufacturer.

6.3 Structural Integrity — Roof Loading.

6.3.1 Any Type I ambulance body shall withstand a force equal to 2.5 times the curb weight of the vehicle applied to the roof of the vehicle's body structure, validated by testing a substantially similar ambulance in accordance with Section 9.1.

6.3.1.1 The modular body shall be tested in accordance with SAE J2422 and ECE R29.

6.3.2 Any Type II ambulance body shall withstand a force equal to 1.5 times the curb weight of the vehicle applied to the roof of the vehicle's body structure, validated by testing a substantially similar ambulance in accordance with Section 9.1.

6.3.3 Any Type III ambulance body shall withstand a force equal to 2.5 times the curb weight of the vehicle applied to the roof of the vehicle's body structure, validated by testing a substantially similar ambulance in accordance with Section 9.1.

6.3.4 The downward vertical movement at any point on the roof application plate shall not exceed 5.12 in. (130 mm).

6.3.5 Each exterior door of the vehicle shall be capable of opening and closing during the full application of the force and after release of the force.

6.3.6 No structural damage to any load bearing or supporting members (i.e., torn or broken material, broken welds, popped or sheared body rivets, bolts, and/or fasteners) shall be evident during the application of the force and after the release of the force.

6.4 Body Structural Integrity — Side Loading.

6.4.1 Any Type I ambulance body shall withstand a force equal to 2.5 times the curb weight of the vehicle applied to either the driver or passenger side of the vehicle's body structure, validated by testing a substantially similar ambulance in accordance with Section 9.1.

6.4.2 Any Type III ambulance body shall withstand a force equal to 2.5 times the curb weight of the vehicle applied to either the driver or passenger side of the vehicle's body structure, validated by testing a substantially similar ambulance in accordance with Section 9.1.

6.5 Body Sealing.

6.5.1 Sealing Out Water.

6.5.1.1 There shall be no water leakage into the cab, any exterior compartment, the patient compartment, or through any door seal, light seal, or cab-to-module seal.

6.5.1.2 Compliance of the body sealing out water shall be validated by testing each finished ambulance in accordance with Section 9.10.

6.5.2 Sealing Out Exhaust Gas. The body shall be sealed and vented so that the interior carbon monoxide level does not exceed 10 ppm of carbon monoxide (CO) above ambient conditions.

6.6 Wheel Housings.

6.6.1 Wheel housings of modular bodies shall include metal or plastic splash shields between the body wheel housing and the wheels extending over the top of the tires to the bottom of the body side skirting.

6.6.2 Wheel house openings shall allow for tire chain usage and easy tire removal and service and conform to SAE J683.

6.6.3 OEM's standard wheel housings on Type II ambulances shall be acceptable.

6.7 Patient Compartment to Cab Partition.

6.7.1 A bulkhead partition shall be provided between the driver and patient compartments.

6.7.2 The partition(s) shall be located directly behind the driver and cab passenger seats when in the rearmost position.

6.7.3 The partition shall extend from the floor to the ceiling.

6.7.4 The partition shall be wide enough to cover the width of each cab seat excluding arm rests.

6.7.5* The ambulance and body bulkheads shall have an aligned window opening of at least 150 in.² (96,780 mm²) or other means of visual and hands-free audio communication.

6.7.6 If equipped with a window in the cab or body, it shall have the sliding type, aligned, and connected with the modular body window opening.

6.7.7 The window shall be latchable from the cab side and shall be a transparent, shatterproof panel.

6.8 Access Handrails or Handholds.

6.8.1 Interior or exterior access handrails or handholds shall be provided at each entrance to a driving or crew compartment and at each position where steps or ladders for climbing are located.

6.8.2 Exterior access handrails shall be constructed of or covered with a slip-resistant (i.e., cross-hatched stainless steel, rubberized, etc.), noncorrosive material.

6.8.3 Exterior access handrails shall be between 1 in. and 1 5/8 in. (25 mm and 42 mm) in diameter and have a minimum clearance between the handrails and any surface of at least 2 in. (50 mm).

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

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

6.8.6 Handrail Testing.

6.8.6.1 Handrails shall withstand a force of 300 lb (136 kg) applied in any direction without detaching, loosening, or permanently deforming.

6.8.6.2 Compliance of the handrail shall be validated by testing a substantially similar ambulance or body structure in accordance with Section 9.8.

6.9 Patient Compartment Entry Doors.

6.9.1 Door handles shall be designed and installed to protect against accidental or inadvertent opening.

6.9.2 Entry doors and door openings shall be designed to minimize inadvertent snagging of apparel.

6.9.3 Door latches, hinges, and hardware furnished by OEM and final stage ambulance manufacturers (FSAMs) shall meet the performance requirements of FMVSS 206.

6.9.4 When doors are open, the hinges, latches, and door-checks shall not protrude into the access area.

6.9.5 Doors shall have hardware or devices to prevent inadvertent closing.

6.9.6 One externally operated lock for each door opening shall be provided.

6.9.7* An internal lock on each patient compartment primary entry door shall be provided.

6.9.8 If a key lock is provided, all patient compartment entry door locks shall be identically keyed.

6.9.9 Doors shall be equipped with not less than 250 in.² (161,300 mm²) of safety glass area per door.
6.9.10 Doors shall be designed to prevent leakage of exhaust fumes, dust, water, and air into the patient compartment.

6.9.11 Doors shall, in addition to meeting applicable FMVSS standards, withstand the loads on the latches and hinges listed in Table 6.9.11 when tested in accordance with Section 9.2.

| Table 6.9.11 Loads Withstood on Ambulance Door Latches and Hinges |
|---------------------------------|-----------------|-----------------|
| Side Door                        | Rear Door        |
| **Transverse Load**              | **Longitudinal Load** |
| Fully latched position           | 2500 lbf (11,120 N) | 2500 lbf (11,120 N) |
| Secondary latched position       | 1500 lbf (6672 N)  | 1500 lbf (6672 N)  |
| Hinge                           | 2500 lbf (11,120 N) | 2500 lbf (11,120 N) |

6.9.11.1 Compliance of the door shall be validated by testing on a patient compartment sample of a substantially similar design.

6.9.11.2 During these tests, the door(s) or its retention components shall not do either of the following:

1. Open at any time during the test procedure
2. Fail at the latch, striker(s), hinge, or their points of attachment to the door or the body framework

6.10 Means of Escape.

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

6.10.2 Each means of escape opening shall be a minimum of 24 in. \( \times \) 24 in. (610 mm \( \times \) 610 mm).

6.11 Exterior Stepping Surfaces and Interior Steps.

6.11.1 All materials used for exterior surfaces designated as stepping, standing, and walking areas and all interior steps shall have a minimum slip resistance in any orientation of 0.68 when tested wet using the English XL tester in accordance with the manufacturer's instructions or 0.52 when tested wet using the Brungraber Mark II tester in accordance with the manufacturer's instructions.

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

6.11.3 Sampling Strategy.

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

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

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

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

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

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

6.11.3.3 The contractor shall deliver with the ambulance a certification that all materials used for exterior surfaces designated as stepping, standing, and walking areas meet the requirements of Section 6.11.

6.12 Exterior Storage.

6.12.1 Doors shall provide secure closure properties.

6.12.2 All hinged doors wider than 14 in. (356 mm) and excluding battery compartments shall have positive hold-open devices that permit one-hand closure.

6.12.3 Hardware shall be rust resistant.

6.12.4 All primary exterior compartment doors shall have latches with locks.

6.12.5 All exterior compartments greater than 4 ft\(^3\) (0.11 m\(^3\)) shall be automatically illuminated when opened and shall meet the requirements of 7.11.7.1.

6.13 Floor.

6.13.1 The patient compartment floor shall be flat, except when the area near the rear entrance door is sloped for a lower entering height.

6.13.2 With the exception of cot retention hardware, the floor shall be unencumbered in the door(s) access and work area.

6.13.3 The floor shall be designed to eliminate voids or pockets where water or moisture can become trapped.

6.13.4 The subfloor construction shall cover the full length and width of the patient compartment.

6.13.5 If plywood is used in the subfloor, it shall be marine or exterior grade.

6.13.6 If the ambulance has a modular body, the subfloor shall be designed to prevent water penetration and shall include a heat shield.

6.13.7 Body Floor Structural Integrity.

6.13.7.1 If the subfloor is constructed of plywood, the plywood shall have an American Plywood Association (APA) floor rating of 16 in. (406 mm) on center or better.

6.13.7.2 If the subfloor is constructed of other than plywood, it shall be tested using a 3 in. (76 mm) disk and have a maximum of 0.125 in. (3 mm) deflection at 200 lb (91 kg) force and a minimum ultimate load of 400 lb (181 kg) for a 16 in. (406 mm) on center load.

6.13.7.2.1 The maximum floor structure spacing shall be used for testing.

6.13.7.2.2 Compliance of the floor structural integrity shall be validated by testing the midpoints of the longest unsupported section of a substantially similar ambulance or floor structure in accordance with the concentrated static load test procedure in ASTM E 661.

6.13.7.2.2.1 If panel joints occur at the maximum span location, then they should be present in the test sample as a worst-case scenario.

6.13.7.3 A drawing of the floor structure and fastening schedule of the subfloor material to the structure is required in the certification report.

6.14 Floor Covering.

6.14.1 Floor covering shall be nonpermeable, seamless, and easily cleaned.

6.14.2 The floor covering shall cover the entire length and width of the compartment’s exposed floor.

6.14.3 Joints, where the floor covering meets the sidewalls, shall be sealed and bordered with corrosion-resistant cove molding, or the floor covering shall extend at least 3 in. (76 mm) up the sidewalls.

6.15 Insulation.

6.15.1 Where the patient compartment is insulated, it shall be insulated with a nonsettling type, verminproof, mildewproof, nontoxic, and nonhygroscopic material that meets the requirements of FMVSS 302.

6.15.2 If fiberglass insulation is used, it shall be protected from exposure to water.

6.16* Interior Storage.

6.16.1 The interior of the patient compartment shall provide enclosed storage cabinetry, compartment space, and shelf space.
6.16.2 Compartment(s) under the floor, with opening panel(s) inside the patient compartment, shall not be acceptable.

6.16.3 When furnished, top opening squad bench lids shall be fitted with an automatic hold-open device and a quick-release slam-type latching device when closed.

6.16.4 Storage compartment door handles, where provided, shall not protrude more than 1 in. (25 mm) if located 14 in. (356 mm) above the floor or higher and not protrude more than 2 in. (51 mm) if located lower than 14 in. (356 mm) above the floor.

6.16.5 Doors shall be designed to remain closed during transport.

6.16.6 Storage compartments shall be firmly fastened to the body structure.

6.17 Interior Surfaces.

6.17.1 The interior of the body shall be free of all sharp projections and sharp corners.

6.17.2 All hangers or supports for equipment and devices shall be mounted as flush as possible with the surrounding surface.

6.17.3 The finish of the entire patient compartment and exterior storage, including interiors of storage cabinets, shall be as follows:

   (1) Impervious to soap, water, body fluids, and disinfectants

   (2) Mildew resistant

   (3) Fire resistant in compliance with FMVSS 302

   (4) Able to be cleaned and disinfected

6.17.4 Countertop horizontal surface shall be seamless and impervious to contaminates.

6.17.5 All edges that meet vertical cabinets shall be sealed.

6.18 Equipment Mounting.

6.18.1 Medical Supplies and Equipment Storage Mounting. Supplies, devices, tools, and so forth shall be stored in enclosed compartments or fastened to secure them during vehicle motion.

6.18.2 Equipment weighing 3 lbs (1.36 kg) or more mounted or stored in a driving or patient area shall be contained in an enclosed compartment capable of containing the contents when a 10G force is applied in the longitudinal, lateral, or vertical axis of the vehicle, if the equipment is secured in a bracket(s) or mount that can contain the equipment when the equipment is subjected to those same forces.

6.18.3 Each patient compartment cabinet shall be permanently labeled on the exterior of the cabinet with its maximum load capacity.

6.19* Waste and Sharps Disposal. A receptacle for general waste and an OSHA-compliant container for sharps disposal shall be provided in the patient compartment.

6.20 Holder for Intravenous Fluid Containers.

6.20.1 One mounted device specifically designed for holding and securing an IV fluid container against accidental release during normal transport activity shall be provided.

6.20.2 The device shall not protrude more than 1.0 in. (25 mm) in the closed position.

6.21 Patient Compartment Seats.

6.21.1 Seat Integrity. Any seat mounted on an adjustable seat device shall be dynamically tested along the direction of the adjustment using the crash pulse in SAE J2917.

6.21.1.1 The test shall be conducted with the seat oriented in the direction of adjustment for both the forward facing and rear facing directions.

6.21.1.2 During and after the test, the seat shall remain securely attached to the adjustment device.

6.21.1.3 Seat belt anchorages on side facing seats shall be tested in accordance with the strength requirements of FMVSS 210.

6.21.2* SCBA Storage. SCBA packs shall not be stored in the seat backs of seats in the patient compartment.

6.21.3 Seat Belts.

6.21.3.1* Each designated seating position shall be provided with a seat belt.

6.21.3.2 Ambulances above 19,500 lb (8845 kg) GVWR shall provide seat belts in accordance with 6.21.3.2.1 and 6.21.3.2.2.

6.21.3.2.1 The effective seat belt web length for a Type 1 lap belt for pelvic restraint shall be a minimum of 60 in. (1524 mm) with the seat adjusted all the way back and down when measured using the following procedure as shown in Figure 6.21.3.2.1:

   (1) Locate an imaginary line where the plane of the center of the seat back surface intersects the plane of the center of the seat cushion surface (see line 1 in Figure 6.21.3.2.1)

   (2) Locate point A on line 1 at the outside of the seat on the retractor side of the seat

   (3) Locate point C on line 1 at the outside of the seat on the receiver side of the seat

   (4) Locate point D at the tip of the receiver

   (5) Pull the seat belt webbing entirely out of the retractor and measure along the webbing between point A and the male seat belt buckle

   (6) Record this length as AD

   (7) Measure from point C to point D and record this length as CD

   (8) Add AD and CD for the effective seat belt web length.

6.21.3.2.2 The effective seat belt web length for a Type 2 pelvic and upper torso restraint-style seat belt assembly shall be a minimum of 110 in. (2800 mm) with the seat adjusted all the way back and down when measured using the following procedure:

   (1) Locate an imaginary line where the plane of the center of the seat back surface intersects the plane of the center of the seat cushion surface (see line 1 in Figure 6.21.3.2.1)

   (2) Locate an imaginary line parallel with line 1 and lying on the center of the seat back surface 29 in. (740 mm) from line 1 (see line 2 in Figure 6.21.3.2.1)

   (3) Locate point A on line 1 at the outside of the seat on the retractor side of the seat

   (4) Locate point B on line 2 at the shoulder strap edge of the seat back

   (5) Locate point C on line 1 at the outside of the seat on the receiver side of the seat

   (6) Locate point D at the tip of the receiver

   (7) Pull the seat belt webbing entirely out of the retractor and measure along the webbing between points A and B

   (8) Record this length as AB

   (9) Measure from point C to point D and record this length as CD

   (10) Add AB and 2CD for the effective seat belt web length
6.21.3.3 Signs that read “Occupants Must Be Seated and Belted When Ambulance Is in Motion” shall be visible from each seated position.

6.21.4 Seated Head Clearance.

6.21.4.1 The minimum seat-to-ceiling dimension from the top surface of the seat bottom cushion to the nearest overhead obstruction for each designated seating position shall be 43 in. (1092 mm).

6.21.4.2 The measurement shall be in accordance with Section 9.25.

6.21.5 Seat Adjustment. When independent horizontal seat adjustment is provided, it shall be fully adjustable within 10 seconds.

6.21.6 Seating Position Width. Each designated seating space shall have a minimum width of 24 in. (610 mm) measured from the seat surface to 43 in. (1092 mm) above the seating surface.

6.21.7 Seat Size.

6.21.7.1 Seat bottom cushions shall be a minimum of 18 in. (460 mm) in width.

6.21.7.2 Seat bottom cushions shall be between 15 in. and 19 in. (380 mm and 483 mm) from the front of the cushion to the face of the seat back.

6.21.7.3 A back cushion that extends from the seat bottom cushion vertically at least 7 in. (460 mm) and that is a minimum of 18 in. (460 mm) wide at the base shall be provided.

6.21.7.4 Each seat shall provide back and head support beginning no more than 24 in. (610 mm) above the seat bottom cushion and continuing to at least 36 in. (914 mm) above the seat bottom cushion.

6.21.7.5 For any seat not covered by FMVSS 202, the top of the seat back or head rest shall be a minimum of 10 in. (254 mm) in width.

6.21.8 Access to Patient.

6.21.8.1 If the primary patient care seat is at the patient torso position, it shall be capable of being adjusted such that the nearest edge of the seat bottom cushion is within 6 in. (152 mm) of the nearest edge of the patient cot.

6.21.8.2 The fore-aft position of the seat shall line up within 6 in. (152 mm) of the centerline of the torso as defined by the cot manufacturer.

6.21.8.3 If the primary patient care seat is at the patient head position, it shall be capable of being adjusted such that the nearest edge of the seat bottom cushion is within 6 in. (152 mm) of the nearest edge of the patient cot.

6.21.8.4 If the designated primary patient care seat is the patient head position, the longitudinal centerline of the seat shall line up within 11 in. (280 mm) of the longitudinal centerline of the cot.

6.21.9 Child Seating Restraints.

6.21.9.1 Any seat with a built-in system suitable for transporting a child or infant shall not be oriented in a side-facing direction during transport.

6.21.9.2 If the ambulance is designed to transport infants in a seat, the ambulance shall include an infant restraint seat or have provisions to accommodate an infant car seat.

6.21.9.3 If the ambulance is designed to transport children in a seat, it shall include a child restraint seat or have provisions to accommodate a child car seat.

6.22 Patient Cot Retention.

6.22.1 Each patient cot retention system shall not fail or release when subjected to the greater of the cot manufacturers recommended retention force or a minimum retention force of 2200 lb (9786N) applied in the longitudinal, lateral, and vertical direction.

6.22.2 Compliance of the cot retention system shall be validated by testing a sample retention device using a substantially similar ambulance or body structure in accordance with Section 9.4.

6.23* HVAC. Connecting hoses for the heating and air conditioning system shall be supported by rubber-insulated metal clamping devices at least every 18 in. (457 mm).

6.23.1 Heating.

6.23.1.1 A heating system shall be provided capable of raising the interior temperature from 32°F to 68°F (0°C to 20°C) within 30 minutes.

6.23.1.2 Compliance of the heating system shall be validated by testing a substantially similar ambulance in accordance with Section 9.12.

6.23.2 Air Conditioning.

6.23.2.1 An air conditioning system shall be provided that is capable of lowering the interior temperature from 95°F to 78°F (35°C to 25°C) at a minimum of 40 percent relative humidity within 30 minutes.

6.23.2.2 Compliance of the air conditioning system shall be validated by testing a substantially similar ambulance in accordance with Section 9.12.

6.23.3 Ventilation.

6.23.3.1 Ventilation system(s) in the patient compartments shall provide a change of ambient air with the vehicle stationary.

6.23.3.2 Ventilation shall be separately controlled within the cab and patient compartments.

6.23.3.3 Fresh air intakes shall not be located near the engine exhaust outlet.

6.23.3.4 A fresh air exhaust fan shall be provided.

6.24 Interior Noise.

6.24.1 The interior sound level in the patient compartment shall not exceed 80 decibels.

6.24.2 Compliance of the patient compartment interior sound shall be validated by testing a substantially similar ambulance in accordance with Section 9.6.

6.25* Reflective Striping.

6.25.1* A retroreflective stripe or combination of stripes shall be affixed to the ambulance in the following proportions:

   (1) 25 percent of the width of the front of the ambulance visible when approaching from the front

   (2) 50 percent of the overall ambulance length visible when approaching from each side

6.25.2 The stripe or combination of stripes shall be a minimum of 4 in. (100 mm) in total vertical width.

6.25.3 The 4 in. (100 mm) wide stripe or combination of stripes shall be permitted to be interrupted by objects (i.e., receptacles, cracks between slats in roll up doors, and so forth) provided the full stripe is seen as conspicuous when approaching the ambulance.

6.25.4 A graphic design shall be permitted to replace all or part of the required striping material if the design or combination thereof covers at least the same perimeter length(s) required by 6.28.1.

6.25.5 Any vertically hinged door shall have at least 60 in.² (38,710 mm²) of retroreflective material affixed to the inside of the door.

6.25.6 At least 50 percent of the rear-facing vertical surfaces, visible from the rear of the ambulance shall be equipped with retroreflective striping in a chevron pattern sloping downward and away from the centerline of the vehicle at an angle of 45 degrees.

6.25.6.1 Each stripe in the chevron shall be a single color alternating between red and either yellow, fluorescent yellow, or fluorescent yellow-green.

6.25.6.2 Each stripe shall be 6 in. (150 mm) in width.

6.25.7 All retroreflective material shall conform to the requirements of ASTM D 4956, Standard Specification for Retroreflective Sheeting for Traffic Control, Section 6.1.1 for Type I Sheeting.

6.25.8 All retroreflective materials that are colors not listed in ASTM D 4956, Section 6.1.1, shall have a minimum coefficient of retroreflection of 10 with observation angle of 0.2 degrees and entrance angle of -4 degrees.

6.25.9 Any printed or processed retroreflective film construction shall conform to the standards required of an integral colored film as specified in ASTM D 4956, Section 6.1.1.

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

6.27 Painting.

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

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

6.28 Oxygen — Main Supply and Installation.
6.28.1 The ambulance shall have a piped medical oxygen system capable of supplying a minimum of 3000 L of medical oxygen.

6.28.2 If a compressed gas cylinder is used, a cylinder-changing wrench shall be furnished, tethered, and secured within the oxygen storage compartment.

6.28.3 All oxygen system controls shall be accessible from inside the vehicle.

6.28.4 An oxygen-capacity indicator shall be visible from the designated primary patient care seating position.

6.28.5 The oxygen outlet shall be accessible from the designated primary patient care seating position.

6.28.6 The purchaser shall specify the quantity and location of oxygen outlets.

6.28.7 Oxygen system shall include the following:
   (1) A pressure regulator
   (2) Low pressure, electrically conductive hose and fittings approved for medical oxygen
   (3) Oxygen piping that is concealed and not exposed to the elements, securely supported to prevent damage, and be readily accessible for inspection and replacement
   (4) Oxygen that is piped to a self-sealing oxygen outlet with a minimum flow rate of 100 L/min at the outlet
   (5) Outlet(s) that is marked and identified and does not interfere with the suction outlet

6.28.8 Oxygen Pressure Regulator.

6.28.8.1 The medical oxygen pressure reducing and regulating valve system shall be provided with the following features:
   (1) An inlet filter at the cylinder
   (2) A line relief valve set at 200 psi (1380 kPa) maximum
   (3) A gauge or digital monitor with a minimum range of 0 psi to 2500 psi (17,237 kPa) graduated in not more than 100 psi (690 kPa) increments
   (4) A locking adjustment preset at 50 psi ± 2 psi line pressure

6.28.8.2 The regulator shall meet the performance as required by 6.28.8.3 at an inlet pressure range from 150 psi to 2500 psi (1034 kPa to 17,237 kPa).

6.28.8.3 With the regulator set at 50 psi ± 2 psi, a 100 L/min minimum flow rate shall be available at all oxygen outlets.

6.28.9 Oxygen Tank Storage.

6.28.9.1 Storage for the main oxygen cylinder shall be accessible for replacement from an outside position.

6.28.9.2 The oxygen compartment shall be provided with at least 9 in.² (580 mm²) of open vent to dissipate/vent leaking oxygen to the outside of the ambulance.

6.28.9.3 Oxygen cylinder compartment shall not be utilized for storage of any other equipment and shall be labeled “Oxygen Storage Only.”

6.28.10 Oxygen Tank Retention.

6.28.10.1 Any oxygen tank shall be retained to withstand a force equal to 25 times the weight of a full tank for which the tank holder was designed.

6.28.10.2 The oxygen tank holder components shall not fail or separate along attachment points.

6.28.10.3 The oxygen tank holder or any component thereof shall not separate from the vehicle at any attachment point.

6.28.10.4 The part of the vehicle to which the oxygen tank holder is attached shall not fail and/or separate at any attachment point.

6.28.10.5 The simulated cylinder shall not disengage from the oxygen tank holder.

6.28.10.6 Compliance of the oxygen tank retention shall be validated by testing a sample retention device using a substantially similar ambulance or body structure in accordance with Section 9.3.

6.28.11 Oxygen System Integrity.

6.28.11.1 The oxygen system of each ambulance shall be tested prior to delivery.

6.28.11.1.1 The oxygen system shall lose no more than 5 psi (34 kPa) of pressure in a 2-hour period.

6.28.11.1.2 Oxygen flow through each outlet shall be capable of delivering at least 100 L/min of oxygen.

6.28.11.1.3 Compliance of the oxygen system integrity shall be validated by testing a sample system in a substantially similar ambulance in accordance with Section 9.15.

6.28.11.2 A label shall be provided near the oxygen tank stating “The integrity of this oxygen system was tested in accordance with NFPA 1917 and meets the requirements thereof.”

6.28.11.3 This label shall be signed and dated by an authorized representative of the ambulance manufacturer or test agency.

6.29 Suction Aspirator.

6.29.1 An electrically powered suction aspirator system shall be furnished.

6.29.2 The vacuum control, vacuum indicator, and collection bottle or bag shall be located so that it can be operated from the primary patient care position.

6.29.3 Any permanently mounted suction pump shall be located in an area that is accessible for service.

6.29.4 Any permanently mounted suction pump shall be vented to the vehicle’s exterior.

6.29.5 A vacuum control and a shutoff valve, or combination thereof, shall be provided to adjust vacuum levels.

6.29.6 A vacuum indicator gauge graduated at least every 2 in. (100 mm) and a minimum total range of 0 in. to 30 in. (0 mm to 760 mm) Hg shall be provided.

6.29.7 The collection bottle or bag shall be shatter resistant and transparent with a minimum 1000 mL capacity.

6.29.8 The minimum inside diameter for the suction tubing connectors shall be at least 1/4 in. (6.4 mm).

6.29.9 Aspirator System Performance.

6.29.9.1 The aspirator system shall provide a free airflow of at least 30 L/min.

6.29.9.2 The aspirator system shall achieve a minimum of 300 mm Hg vacuum within 4 seconds after the suction tube is closed.

6.29.9.3 Compliance of the aspirator system shall be validated by testing a sample aspirator system installed in a substantially similar ambulance in accordance with Section 9.21.

Chapter 7 Low Voltage Electrical Systems and Warning Devices

7.1* General. Any low voltage electrical systems or warning devices installed on the ambulance shall be appropriate for the mounting location and intended electrical load and shall meet the specific requirements of Chapter 7.

7.1.1 Printed Circuits.

7.1.1.1 When printed circuits are utilized, they shall conform to IPC A-610D, “Acceptability of Electronic Assemblies.”

7.1.1.2 Printed circuit assemblies provided shall qualify under IPC A-610D Classification I.4.1 as Class 2 “For Commercial and Industrial Assemblies” or better.

7.1.1.3 Printed circuit board connections and components shall conform to all other specification requirements.

7.1.2 Electrical System Performance Tests. The low voltage electrical system performance test shall be done according to Section 9.1.

7.2 Wiring.

7.2.1 All electrical circuit feeder wiring supplied and installed by the ambulance manufacturer shall meet the requirements of 7.2.1.1 through 7.2.1.6.

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

7.2.1.2 Voltage drops in all wiring from the power source to the using device shall not exceed 0.5 volts.

7.2.1.3 The use of star washers for circuit ground connections shall not be permitted.
7.2.1.4 All circuits shall otherwise be wired in conformance with SAE J1292, Automobile, Truck, Truck-Tractor, Trailer, and Motor Coach Wiring.

7.2.1.5 Only electrical components directly related to the delivery of on-board oxygen shall terminate in the oxygen storage compartment.

7.2.1.6 If electrical harnesses or wires pass through the oxygen compartment, it shall be enclosed in conduit.

7.2.2 Wiring and Wire Harness Construction.

7.2.2.1 All insulated wire and cable shall conform to SAE J1127, Low Voltage Battery Cable, or SAE J1128, Low Voltage Primary Cable, type SXL, GXL, or TXL.

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

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

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

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

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

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

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

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

7.2.2.5 All ungrounded electrical terminals and electrical panels shall have protective covers or be in enclosures.

7.2.2.6 A minimum 6 in. (152 mm) service loop of wire or harness shall be provided at all electrical components, terminals, and connection points.

7.2.2.7 All wiring connecting to exterior lights and fixtures shall utilize sealed connectors or splices.

7.2.2.8 Wiring Protection.

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

7.2.2.8.2 Wiring shall not be secured to brake lines and/or fuel lines.

7.2.2.9* Wiring Identification.

7.2.2.9.1 Wiring shall be uniquely identified at least every 4 in. (101 mm) by color coding or permanent marking with a circuit function code.

7.2.2.9.2 The identification shall reference a wiring diagram. [See 4.17.2.3(6).]

7.2.2.9.3 The wiring diagram shall have an alphabetical list of all identifiers and their location on the diagram.

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

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

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

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

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

7.2.2.11 Terminals.

7.2.2.11.1 All terminals shall be permanently numbered or coded.

7.2.2.11.2 A terminal strip(s) block(s) or a multi-pin connector(s) shall be readily accessible for checking and service.

7.2.2.12 Hard-wired patient compartment electrical systems shall incorporate a master circuit breaker panel with circuit breakers or other electronic nondisposable, current protection devices, in each circuit, which comply with SAE J553 Type I or Type III (if circuit breaker is readily accessible for resetting by the driver or EMSP).

7.2.2.12.1 Multiplexed patient compartment electrical systems shall incorporate centralized circuit protection devices on each power circuit supplying the multiplexing system’s components.

7.2.2.13 One extra circuit, minimum 15 amperes, shall be provided for future use.

7.2.2.14 Grounding.

7.2.2.14.1 All electrical components or appliances shall be electrically grounded in accordance with the component manufacturer’s recommendations.

7.2.2.14.2 The use of appliance mounting screws/hardware shall not be used for grounding purposes, unless specifically designed for that purpose.

7.2.2.15 All switches, indicators, and controls shall be located and installed in a manner that facilitates easy removal.

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

7.2.2.17 The patient compartment interior and exterior electrical circuits shall be powered by circuit(s) separate and distinct from vehicle chassis circuits, unless specific chassis circuits are supplied for that purpose by the chassis manufacturer.

7.3 Power Supply.

7.3.1 A 12 volt or greater electrical alternator shall be provided.

7.3.2* Low Idle Alternator Output.

7.3.2.1 The alternator shall have a minimum output at low idle to meet the minimum electrical load test conditions of the ambulance between 60°F and 110°F (15°C and 43°C) ambient temperature.

7.3.2.1.1 Minimum electrical load test conditions, which are tested under low-idle conditions, shall consist of the following:

(1) The propulsion engine and transmission
(2) All legally required clearance and marker lights, headlights, and other electrical devices except windshield wipers and four-way hazard flashers
(3) The radio(s) at a duty cycle of 10-percent transmit and 90-percent receive (for calculation and testing purposes, a default value of 5 amperes continuous)
(4) Cab air conditioning (at coldest setting with highest blower speed)
(5) Patient compartment air conditioning (at coldest setting with highest blower speed)
(6) The lighting necessary to illuminate walking surfaces at entry points

7.3.2.2 Compliance of the minimum electrical load test conditions shall be validated by testing a substantially similar ambulance in accordance with 9.5.3.3.

7.3.3 The alternator shall be provided with full automatic regulation.

7.3.4 High-Idle Alternator Output.

7.3.4.1 The alternator shall have a minimum output at high idle to power the operational electrical load test conditions between 60°F and 110°F (15°C and 43°C) ambient temperature.

7.3.4.2 Compliance of the high-idle alternator output shall be validated by testing a substantially similar ambulance in accordance with 9.1.2.3.

7.4 Operational Electrical Load Test Conditions

7.4.1 The operational electrical load test conditions minimum continuous electrical load shall consist of the total amperage required to simultaneously operate the following in a stationary mode during emergency operations:
1 The propulsion engine and transmission

2 All legally required clearance and marker lights, headlights, and other electrical devices except windshield wipers and four-way hazard flashers

3 The radio(s) at a duty cycle of 10-per cent transmit and 90-per cent receive (for calculation and testing purposes, a default value of 5 amperes continuous)

4 The lighting necessary to illuminate walking surfaces at entry points and 50 percent of the total compartment light load as required by this standard

5 The minimum optical warning system required in Section 7.8, where the ambulance is blocking the right-of-way

6 The continuous electrical current required to simultaneously operate an additional 20-ampere load

7 Cab air conditioning (at coldest setting with highest blower speed)

8 Patient compartment air conditioning (at coldest setting with highest blower speed)

9 Patient compartment dome lighting (in the high intensity setting)

10 Other warning devices and electrical loads defined by the purchaser as critical to the mission of the ambulance

7.4.2 If the ambulance is equipped to tow a trailer, an additional 45 amperes shall be added to the minimum continuous electrical load to provide electrical power for the federally required clearance and marker lighting and the optical warning devices mounted on the trailer.

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

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

7.4.3.2 Voltage Alarm.

7.4.3.2.1 The alarm shall sound if the system voltage at the battery or at the master load disconnect switch drops below 11.8 volts for 12-volt nominal systems, 23.6 volts for 24-volt nominal systems, or 35.4 volts for 42-volt nominal systems for more than 120 seconds.

7.4.3.2.2 Compliance of the voltage alarm shall be validated by testing a substantially similar ambulance in accordance with 9.5.3.

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

7.5 Load Management.

7.5.1* If the total continuous electrical load exceeds the minimum continuous electrical output rating of the installed alternator(s) operating under the conditions specified in 7.4.1, an automatic electrical load management system shall be required.

7.5.2 The minimum continuous electrical loads specified in 7.4.1 shall not be subject to automatic load management.

7.5.3 Engine Speed Auxiliary Control Device.

7.5.3.1 An engine speed auxiliary control device (high-idle switch or throttle) shall be installed to allow an increase in the engine speed when the apparatus is parked.

7.5.3.2 An interlock shall prevent the operation of the engine speed auxiliary control device unless the parking brake is engaged and the transmission is in neutral or park, or the parking brake is engaged and the engine is disengaged from the drive wheels.

7.5.3.3 The engine shall be prevented from regulating its own engine speed during times when engine rpm control is critical for consistent ambulance functions.

7.6 Batteries.

7.6.1 Continuous Electrical Load.

7.6.1.1 With the engine off, the battery system shall be able to provide the minimum electrical load test conditions specified in 7.4.1 for 10 minutes and then be able to restart the engine.

7.6.1.2 Compliance of the battery system shall be verified on every ambulance prior to delivery in accordance with 9.5.2.2.
7.9.3 For the purposes of defining and measuring the required optical performance, the upper and lower warning levels shall be divided into four warning zones.

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

7.9.3.2 The four zones shall be designated A, B, C, and D in a clockwise direction, with zone A to the front of the ambulance as shown in Figure 7.9.3.2.

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

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

7.9.6 The optical warning system on the ambulance shall be capable of two separate signaling modes during emergency operations.

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

7.9.6.2 One mode shall signal that the ambulance is stopped and is blocking the right-of-way.

7.9.6.3 The use of some or all of the same warning lights shall be permitted for both modes provided the other requirements of this chapter are met.

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

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

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

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

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

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

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

7.9.11 Flash Rate.

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

7.9.11.1.1 Steadily burning, nonflashing optical sources shall be permitted to be used.

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

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

7.9.12* Color of Warning Lights.

7.9.12.1 Permissible colors or combinations of colors in each zone, within the constraints imposed by applicable laws and regulations, shall be as shown in Table 7.9.12.1.

<table>
<thead>
<tr>
<th>Color</th>
<th>Calling for Right-of-Way</th>
<th>Blocking Right-of-Way</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Any zone</td>
<td>Any zone</td>
</tr>
<tr>
<td>Blue</td>
<td>Any zone</td>
<td>Any zone</td>
</tr>
<tr>
<td>Yellow</td>
<td>Any zone except A</td>
<td>Any zone</td>
</tr>
<tr>
<td>White</td>
<td>Any zone except C</td>
<td>Not permitted</td>
</tr>
</tbody>
</table>

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

7.9.13* Requirements for Large Ambulances.

7.9.13.1 If the ambulance has a bumper-to-bumper length of 25 ft (7.6 m) or more or has an optical center on any optical warning device greater than 8 ft (2.4 m) above level ground, the requirements of 7.9.13.2 through 7.9.13.6 shall apply.

7.9.13.2 Upper-Level Optical Warning Devices.

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

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

7.9.13.3 Lower-Level Optical Warning Devices.

7.9.13.3.1 To define the clearance lines of the ambulance, the optical center of the lower-level optical warning devices in the front of the vehicle shall be mounted on or forward of the front axle centerline and as close to the front corner points of the ambulance as is practical.

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

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

7.9.13.4 Midship Optical Warning Devices.

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

7.9.13.4.2 Additional midship optical warning devices shall be required, where necessary, to maintain a horizontal distance between the centers of adjacent lower-level optical warning devices of 25 ft (7.6 m) or less.
7.9.13.4.3 The optical center of any midship-mounted optical warning device shall be between 18 in. and 62 in. (460 mm and 1600 mm) above level ground.

7.9.13.5* For each operating mode, the combined optical power of all the optical sources shall meet or exceed the zone total optical power requirements shown in Table 7.9.13.5.

<table>
<thead>
<tr>
<th>Mode of Operation</th>
<th>Zone</th>
<th>Level</th>
<th>Calling for Right-of-Way</th>
<th>Blocking Right-of-Way</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>At Any H Point</td>
<td>At Any Point 5 Degrees Up or 5 Degrees Down from H</td>
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<tr>
<td>Zone</td>
<td></td>
<td></td>
<td>H Total</td>
<td>At Any H Point</td>
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<tr>
<td>A</td>
<td>Upper</td>
<td>1,000,000</td>
<td>10,000</td>
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<tr>
<td>B</td>
<td>Upper</td>
<td>400,000</td>
<td>10,000</td>
<td>3,500</td>
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<tr>
<td>C</td>
<td>Upper</td>
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<td>Upper</td>
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<td>10,000</td>
<td>3,500</td>
</tr>
<tr>
<td>A</td>
<td>Lower</td>
<td>150,000</td>
<td>3,750</td>
<td>1,300</td>
</tr>
<tr>
<td>B</td>
<td>Lower</td>
<td>150,000</td>
<td>3,750</td>
<td>1,300</td>
</tr>
<tr>
<td>C</td>
<td>Lower</td>
<td>150,000</td>
<td>3,750</td>
<td>1,300</td>
</tr>
<tr>
<td>D</td>
<td>Lower</td>
<td>150,000</td>
<td>3,750</td>
<td>1,300</td>
</tr>
</tbody>
</table>

Notes:
1. All values are in candela-seconds/minute.
2. The values in the H Total columns are the total of 19 data point values for each light, with data points on the boundary between zones counted in both zones.

7.9.13.6 No individual measurement point shall be less than that shown in Table 7.9.13.5.

7.9.14* Requirements for Small Ambulances.

7.9.14.1 If the ambulance has a bumper-to-bumper length of less than 25 ft (7.6 m) and has the optical center of all optical warning devices at 8 ft (2.4 m) or less above level ground, the requirements of 7.9.14.2 through 7.9.14.5 shall apply.

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

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

7.9.14.3 Lower-Level Optical Warning Devices.
7.9.14.3.1 One or more lower-level optical warning devices shall be visible from the front and the side of the ambulance.

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

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

7.9.14.4 For each operating mode, the combined optical power of all the optical sources mounted on both the upper and lower levels shall meet or exceed the zone’s total optical power requirements shown in Table 7.9.14.4.

(See Table 7.9.14.4 on the following page.)
Directional Flashing Optical Warning Devices for Authorized Emergency, Maintenance, and Service Vehicles

7.9.15 Tests of Optical Warning Devices.

7.9.15.1 Mechanical and Environmental Test.

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

7.9.15.1.2 Optical devices and components designed for mounting only in weatherproof, interior spaces shall be tested in conformance with the applicable SAE standard listed in 7.9.15.1.1 and shall comply with the vibration test and the warpage test for plastic components.

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

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

7.9.15.2 Photometric Test Procedures for Optical Devices.

7.9.15.2.1 Testing shall be performed by, or on behalf of, the device manufacturer to ensure compliance with the requirements of 7.9.15.2.2 through 7.9.15.2.2.2.

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

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

7.9.15.2.3 For all tests performed with the power applied, the lighting system, component thereof, shall be operated at 12.8 volts ± 0.1 volt for 12-volt nominal equipment, 25.6 volts ± 0.2 volt for 24-volt nominal equipment, and 38.4 volts ± 0.3 volt for 42-volt nominal equipment.

7.9.15.2.3.1 If the equipment is rated for operation on multiple voltages, the tests shall be performed at each of the rated voltages used by the equipment.

7.9.15.2.3.2 Voltage shall be measured at a point 12 in. ± 1 in. (300 mm ± 25 mm) from the entry into the component.

7.9.15.2.4 The technique described in 7.9.15.2.2 through 7.9.15.2.2.2 shall be performed along the horizontal plane that passes through the optical center, beginning at the optical center and repeated at 5-degree intervals to the left and to the right of the optical center throughout the active horizontal angle of light emission of the optical source.

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

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

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

7.9.16 Compliance Documentation. The ambulance manufacturer shall demonstrate compliance of the warning system by one of the following methods:

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

7.9.17 Alternate Lighting Systems.

7.9.17.1 An emergency lighting system shall provide the ambulance with 360 degrees of conspicuity for safety during its missions.

---

Table 7.9.14.4 Minimum Optical Power Requirements for Small Ambulance

<table>
<thead>
<tr>
<th>Mode of Operation</th>
<th>Calling for Right-of-Way</th>
<th>Blocking Right-of-Way</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At Any H Point</td>
<td>At Any H Point</td>
</tr>
<tr>
<td></td>
<td>5 Degrees Up or</td>
<td>5 Degrees Down from H</td>
</tr>
<tr>
<td></td>
<td>5 Degrees Down from H</td>
<td></td>
</tr>
<tr>
<td>Zone</td>
<td>H Total</td>
<td>H Total</td>
</tr>
<tr>
<td>A</td>
<td>1,000,000</td>
<td>400,000</td>
</tr>
<tr>
<td>B</td>
<td>200,000</td>
<td>200,000</td>
</tr>
<tr>
<td>C</td>
<td>400,000</td>
<td>800,000</td>
</tr>
<tr>
<td>D</td>
<td>200,000</td>
<td>200,000</td>
</tr>
</tbody>
</table>

Notes:

1. All values are in candela-seconds/minute.
2. The values in the H Total columns are the total of 19 data point values for each light, with data points on the boundary between zones counted in both zones.

---
7.9.17.1.1 The system shall display highly perceptible and attention getting signals that function in a modular system, and convey the following messages:

1. In the “PRIMARY MODE — Clear the Right-of-Way”
2. In the “SECONDARY MODE — Hazard, Vehicle Stopped on Right-of-Way”

7.9.17.1.2 The ambulance standard warning light system shall not impose a continuous average electrical load exceeding 40 amperes at 14.2 volts.

7.9.17.1.3 The warning light systems shall not impair the effectiveness of the legally required exterior lighting on the ambulance.

7.9.17.2 The ambulance standard emergency warning light system shall contain twelve fixed red lights, one fixed clear light and one or more fixed amber light(s).

7.9.17.2.1 These lights shall function in a dual mode system as shown in Figure 7.9.17.2.1 and meet the physical and photometric requirements.

7.9.17.2.2 The upper body warning lights shall be mounted at the extreme upper corner areas of the ambulance body.

7.9.17.2.3 The single clear light shall be centered between the two front-facing, red, upper corner lights or in a dedicated housing mounted forward of the body on the cab roof.

7.9.17.2.3.1 If due to limited body dimensions and physical size of the outboard forward-facing lights, the lights shall also be mounted in dedicated housings on the cab roof.

7.9.17.2.4 Doors or other ancillary equipment shall not obstruct the standard warning lights.

7.9.17.2.5 The amber light shall be symmetrically located between the two rear-facing red lights.

7.9.17.2.6 The red “grille” lights shall be located at least 30 in. (762 mm) above the ground and below the bottom edge of the windshield and be laterally separated by at least 18 in. (457 mm), measured from centerline to centerline of each lamp.

7.9.17.2.7 The lateral-facing intersection lights shall be mounted as close as possible to the front upper edge of each front fender and can be angled forward a maximum of 30 degrees.

7.9.17.2.8 All warning lights furnished shall be mounted to project their highest intensity beams on the horizontal plane.

7.9.17.3 Photometric, Chromaticity, and Physical Requirements.

7.9.17.3.1 Each emergency light shall flash 75 to 125 times per minute.

7.9.17.3.2 The chromaticity values of the lights shall conform to SAE J578, for their respective color, except for the red lights, which can conform to the following expanded boundary limits of $y = 0.34$, $y = 0.32$, and $x = 0.62$.

7.9.17.3.3 All warning lights shall project a beam spread of at least 5 degrees up and 5 degrees down and at least 45 degrees left and right of horizontal and vertical (H-V).

7.9.17.3.4 Each light shall produce flash energy, (Cd-s) per flash, measured from the H-V to all the extreme test point coordinates and shall be tested at all 5-degree increments.

7.9.17.3.4.1 At no point shall the Cd-s values drop to less than the minimum values as shown in Table 7.9.17.2.1 when tested at 14.2 volts.

7.9.17.3.4.2 Flash energy shall be determined in accordance with the SAE J845 method for determining the flash energy of a light.

7.9.17.3.5 Testing shall be conducted on the device(s) as manufactured including use of the actual light source and all other related system components.

7.9.17.4 The emergency light switches shall be wired and arranged to provide the warning light signal modes and combinations as specified.

7.9.17.4.1 All emergency light switches shall be labeled, and each primary/secondary mode switch shall have an indicator light to show the driver which mode is activated.

### Table 7.9.17.2.1 Emergency Lighting

<table>
<thead>
<tr>
<th><strong>COLOR &amp; LOCATION</strong></th>
<th><strong>RED</strong></th>
<th><strong>CLEAR</strong></th>
<th><strong>AMBER</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Front and rear corners</td>
<td>On</td>
<td>On</td>
<td>On</td>
</tr>
<tr>
<td>Front upper center</td>
<td>Off</td>
<td>On</td>
<td>Off</td>
</tr>
<tr>
<td>Rear center</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
</tr>
<tr>
<td>Grill and fender</td>
<td>On</td>
<td>Off</td>
<td>Off</td>
</tr>
</tbody>
</table>

*Optional forward facing light locations on cab roof for two red and single center clear lights.

**Optional rear amber lights in lieu of single center light.

1. Indicates lights flashing at the same time.
2. Indicates lights flashing 180 degrees out of phase with 1.

### Table 7.9.17.3.1 Photometric Requirements

<table>
<thead>
<tr>
<th><strong>LOCATION</strong></th>
<th><strong>RED</strong></th>
<th><strong>CLEAR</strong></th>
<th><strong>AMBER</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Grill and fenders</td>
<td>160 Cd-S @ HV</td>
<td>240 Cd-S @ HV</td>
<td>900 Cd-S @ HV</td>
</tr>
<tr>
<td>Upper body corners</td>
<td>80 Cd-S @ ± 5° H points</td>
<td>120 Cd-S @ ± 5° H points</td>
<td>450 Cd-S @ ± 5° H points</td>
</tr>
<tr>
<td>Front center</td>
<td>12 Cd-S @ all 5°V – 45°H points</td>
<td>32 Cd-S @ all 5°V – 45°H points</td>
<td>96 Cd-S @ all 5°V – 45°H points</td>
</tr>
<tr>
<td>Rear center</td>
<td>72 Cd-S @ all 5°V – 45°H points</td>
<td>72 Cd-S @ all 5°V – 45°H points</td>
<td></td>
</tr>
</tbody>
</table>

*Single center rear or combined dual rear (optional).
7.11.3.5 Load lights shall turn on whenever the rear patient entry doors are unobstructed by open doors.

7.11.3.4 The loading area shall be illuminated to a level of at least 1 fc within the first 5 ft (1.5 m) from the vehicle and 0.3 fc up to 10 ft (3 m) from the vehicle.

7.11.3.3 Compliance of the load lighting illumination shall be validated by testing a substantially similar ambulance in accordance with Section 9.24.

7.11.3.2 Load lights shall be not less than 75 in. (1.9 m) above the ground and unobstructed by open doors.

7.11.3.1 The loading area shall be illuminated to a level of at least 1 fc within the first 5 ft (1.5 m) from the vehicle and 0.3 fc up to 10 ft (3 m) from the vehicle.

7.11.2 Scene Lighting.

7.11.2.1 Scene lights shall be located on both the sides of the ambulance.

7.11.2.2 Scene lights shall be not less than 75 in. (1.9 m) above the ground and unobstructed by open doors.

7.11.2.3 Scene light switches shall be located on the cab console and control each side independently.

7.11.1 Scene Lightings.

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

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

7.10 Audible Warning Devices.

7.10.1 Audible warning equipment in the form of at least one automotive traffic horn and one electric or electronic siren shall be provided.

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

7.10.1.2* A means shall be provided to allow the activation of the siren within reach of the driver.

7.10.2 Where furnished, air horns, electric siren(s), and electronic siren speaker(s) shall be mounted as low and as far forward on the ambulance as is practical.

7.10.3 Audible warning equipment shall not be mounted on the roof of the ambulance.

7.11 Exterior and Interior Lighting.

7.11.1 All light level measurements shall be made with a light meter with a hemispherical light sensor held against the surface, facing perpendicular to the surface, and not deliberately pointed toward the light source.

7.11.1.1 Scene lightings.

7.11.1.2 Scene lights shall be located on both the sides of the ambulance.

7.11.1.3 Load lighting.

7.11.1.4 Ambulance Exterior DOT Lighting.

7.11.1.4.1 The exterior ambulance lighting shall include all required FMVSS 108 lighting.

7.11.1.4.2 The lower front and rear side marker lights shall flash in conjunction with the directional signals.

7.11.5 Ground Lighting.

7.11.5.1 The ambulance shall be equipped with lighting that is capable of providing illumination at a minimum level of 0.3 fc on ground areas within 30 in. (800 mm) of the edge of the ambulance in areas designed for personnel to climb into or onto the ambulance or descend from the ambulance to the ground level.

7.11.5.2 Lighting designed to provide illumination on areas under the driver and crew riding area exits shall be switchable but activated automatically when the exit doors are opened.

7.11.5.3 All other ground area lighting shall be switchable.

7.11.6 Interior Lighting.

7.11.6.1 The lighting manufacturers shall furnish and certify, or the ambulance manufacturer shall measure and record, the total average current load of the standard emergency warning light system on the vehicle as manufactured at the regulated voltage of 14.2 volts, when operated in the mode that draws maximum current.

7.11.6.2 The lighting manufacturer's own labs and listed with the AMECA for compliance with the requirements in this specification; AMECA Compliance Handbook for GSA and SAE Warning Lamp Systems.

7.11.6.3 Patient Compartment Illumination.

7.11.6.3.1 The ambulance interior lighting configuration shall be designed to minimize electrical loads.

7.11.6.3.2 Any lighting circuit shall not consume more than 25 amperes and shall have separately protected and controlled circuits.

7.11.6.3.3 All interior lighting fixtures shall not protrude more than 1.5 in. (38 mm) from the mounting surface.

7.11.6.3.4 All interior lighting fixtures shall be switchable but activated automatically when the side entry or rear entry patient compartment doors are opened.

7.11.6.3.5 The patient compartment lighting shall be automatically activated in the low setting when the side entry or rear entry patient compartment doors are opened.

7.11.7 Compartment Lighting.

7.11.7.1 Each enclosed tool and equipment compartment greater than 4 ft³ (0.11 m³) in volume and having an opening greater than 144 in.² (0.92900 mm²) shall have sufficient compartment lighting to provide a minimum of 1 fc at any location on the floor of the compartment without any shelves, dividers, or equipment in the compartment.

7.11.7.2 Switches for all compartment lighting shall be readily accessible.

7.11.7.3 The lights shall be arranged or protected to minimize accidental breakage.

7.11.8 Testing. All interior and exterior lights mounted in wet locations shall be tested in conformance with SAE J575, Test Methods and Equipment for Lighting Devices and Components for Use on Vehicles Less Than 2032 mm in Overall Width, and shall comply with the following performance requirements of that standard:

(1) Vibration

(2) Moisture
Chapter 8 Line Voltage Electrical Systems

8.1 General. The ambulance shall be furnished with an alternating current (ac) line voltage electrical system consisting of a power source and a 2-wire plus ground wiring system that meets the applicable requirements of this chapter.

8.2 General Requirements.

8.2.1 Conformance with National Electrical Code. All components, equipment, and installation procedures shall conform to NFPA 70, National Electrical Code, except where superseded by the requirements of this chapter.

8.2.1.1 Where the requirements of this chapter differ from those in NFPA 70, the requirements in this chapter shall apply.

8.2.1.2 Where available, line voltage electrical system equipment and materials included on the apparatus shall be listed and used only in the manner for which they have been listed.

8.2.1.3 All equipment and materials shall be installed in accordance with the manufacturer’s instructions.

8.2.2 Shoreline Inlet.

8.2.2.1* The ambulance shall be equipped with a line voltage power inlet known as a shoreline inlet.

8.2.2.2 The shoreline inlet shall be a permanently mounted with a male recessed-type receptacle with cover, having a minimum rating of 15 amperes and conforming to the NEMA configuration appropriate for the voltage rating.

8.2.2.3 The shoreline inlet shall be wired directly to the system or device to be powered or wired to a transfer switch where required by 8.8.2.

8.2.2.4 When an external power source is connected to the shoreline receptacle, it shall energize the vehicle’s internal line voltage circuit.

8.2.2.5 A proper mating, weatherproof, female connector body conforming to the NEMA configuration provided in 8.2.2.2 shall also be furnished without cable and tagged specifying the size, type of wire necessary, and the polarity of the future hookup.

8.2.2.6 The connection shall be permanently labeled as shown in Figure 8.2.2.6.

8.2.2.7 The protective ground from the shoreline inlet shall be bonded to the vehicle frame.

8.2.3 Receptacle.

8.2.3.1 The shoreline receptacle shall energize the vehicle’s internal line voltage circuit from an external power source such as utility power.

8.2.3.2 A proper mating, weatherproof, minimum 15-ampere connector body conforming to the NEMA configuration shall also be furnished without cable and tagged specifying the size, type of wire necessary, and the polarity of the future hookup.

8.2.4 Stability.

8.2.4.1 Any fixed line voltage power source producing alternating current (ac) shall produce electric power at 60 Hz ± 3 Hz when producing power at all levels between no load and full rated power.

8.2.4.2 Any fixed line voltage power source shall produce electric power at the rated voltage ±10 percent when producing power at all levels between no load and full rated power.

8.2.4.3 Any fixed line voltage power source shall produce a maximum voltage output of no more than 10 percent of the power source’s full rated voltage.

8.2.4.4 Higher voltage shall be permitted only when used to operate fixed wired, permanently mounted equipment on the ambulance.

8.2.5 Conformance with National Electrical Code.

8.2.5.1 All components, equipment, and installation procedures shall conform to NFPA 70, National Electrical Code, except where superseded by the requirements of this chapter.

8.2.5.2 Where the requirements of this chapter differ from those in NFPA 70, the requirements in this chapter shall apply.

8.2.5.3* Where available, line voltage electrical system equipment and materials included on the ambulance shall be listed and used only in the manner for which they have been listed.

8.2.5.4 All equipment and materials shall be installed in accordance with the manufacturer’s instructions.

8.2.6 Location Ratings.

8.2.6.1 Any equipment used in a dry location shall be listed for dry locations.
8.3.1* Grounding. Grounding shall be in accordance with 250.34(A) and 250.34(B) of NFPA 70.

8.3.1.1 Grounding shall be in accordance with 250.34(A) and 250.34(B) of NFPA 70.

8.3.1.2* Grounding shall be in accordance with 250.6, “Portable and Vehicle Mounted Generators,” of NFPA 70.

8.3.1.3 Ungrounded systems shall not be used.

8.3.1.4* Only stranded copper with green colored insulation or green with yellow tracer insulation or braided copper conductors shall be used for grounding and bonding.

8.3.1.5 The grounded current-carrying conductor (neutral) shall be insulated from the equipment-grounding conductors and from the equipment enclosures and other grounded parts.

8.3.1.6 The neutral conductor shall have white or gray colored insulation in accordance with 200.6, “Means of Identifying Grounded Conductors,” of NFPA 70.

8.3.1.7 Any bonding screws, straps, or buses in the distribution panelboard or in other system components between the neutral and equipment-grounding conductor shall be removed and discarded.

8.3.2 Interior Equipment Grounding.

8.3.2.1 In the line voltage electrical system, all exposed metal components shall be effectively bonded to the grounding terminals or enclosure of the distribution panelboard.

8.3.2.2* 8.3.2.2.4 Grounding of electrical equipment shall be done in one of the following ways:

(1) Connection to a metal raceway, conduit, or electrical metallic tubing

(2) A connection between one or more equipment grounding conductors and a metal box by means of a grounding screw that is used for no other purpose or a listed grounding device

8.3.2.2.1 The equipment grounding conductor shall be permitted to be secured under a screw, other than a mounting screw or cover screw, that is threaded into the fixture canopy.

8.3.2.2.2 The equipment grounding conductor and fixture attachment screws shall be permitted to be attached to a listed grounding means (plate) in a nonmetallic outlet box for fixture mounting.

8.3.2.2.3 A connection between the one or more equipment grounding conductors brought into a nonmetallic outlet box shall be so arranged that a connection can be made to any fitting or device in that box that requires grounding.

8.3.2.2.4 Where more than one equipment grounding conductor or branch circuit enters a box, all such conductors shall be in electrical contact with each other and the arrangement shall be such that the disconnection or removal of a receptacle, fixture, or other device fed from the box will not interfere with or interrupt the grounding continuity.

8.3.2.2.5 Cord-connected appliances shall be grounded by means of an approved cord with equipment grounding conductor and grounding attachment plug.

8.3.3 Bonding.

8.3.3.1 The neutral conductor of the power source shall be bonded to the vehicle frame.

8.3.3.2 The neutral bonding connection shall occur only at the power source.

8.3.3.3 In addition to the bonding required for the low voltage return current, each body and each driving or crew compartment enclosure shall be bonded to the vehicle frame by a copper conductor.

8.3.3.4 A bonding conductor shall be connected between the distribution panelboard and an accessible terminal on the chassis.

8.3.3.5 The ambulance body and exterior covering shall be considered bonded when the following criteria has been met:

(1) The metal panels overlap one another and are securely attached to the metal frame parts by metal fasteners or welding.-

(2) The lower panel of the metal exterior covering is secured by metal fasteners at each cross member of the chassis, or the lower panel is bonded to the chassis by a metal strap.

8.3.3.6 Metal circulating air ducts shall be bonded to the chassis.

8.3.3.7 The compressed gas pipes shall be bonded to the chassis.

8.4* Ground-Fault Circuit Interrupters. All line voltage ac circuits of the ambulance shall be protected by listed ground-fault circuit interrupters in accordance with ANSI/UL 498, Standard for Safety Attachment Plugs and Receptacles.

8.5 Power Source General Requirements. The requirements in 8.5.1 through 8.5.10 shall apply to all line voltage power sources.

8.5.1 All power source system mechanical and electrical components shall be sized to support the continuous duty nameplate rating of the power source.

8.5.2 The power source shall be shielded from contamination that would prevent the power source from operating within its design specifications.

8.5.3 Generators. If the power source is mechanically driven and mounted on the vehicle, it shall comply with Article 445, “Generators,” of NFPA 70.

8.5.4 Power Source Rating.

8.5.4.1* For power sources of 8 kW or larger, the power source manufacturer shall declare the continuous duty rating that the power source can provide when installed on ambulance according to the manufacturer’s instructions and run at 120°F (49°C) air intake temperature at 2000 ft (600 m) above sea level.

8.5.4.2 The rating on the power source specification label shall not exceed the declared rating from the power source manufacturer.

8.5.5 Access shall be provided to permit both routine maintenance and removal of the power source for major servicing.

8.5.6 The power source shall be located such that neither it nor its mounting brackets interfere with the routine maintenance of the ambulance.

8.5.7 Instrumentation.

8.5.7.1 If the power source is rated at less than 3 kW, a “Power On” indicator shall be provided.

8.5.7.2 If the power source is rated at 3 kW or more but less than 8 kW, a voltmeter shall be provided.

8.5.7.3* If the power source is rated at 8 kW or more, the following instrumentation shall be provided at an operator’s panel:

(1) Voltmeter

(2) Current meters for each ungrounded leg

(3) Frequency (Hz) meter

(4) Power source hourmeter

8.5.7.4 The instrumentation shall be permanently mounted at an operator’s panel.

8.5.7.4.1 The instruments shall be located in a plane facing the operator.
8.6.2.3 Hydraulic Components.

8.6.2.3.1 A hydraulic system filter and strainer shall be provided and shall be located in a readily accessible area.

8.6.2.3.2 Hydraulic hose shall meet the hydraulic pump manufacturer’s recommendations for pressure, size, vacuum, and abrasion resistance.

8.6.2.3.3 Hydraulic fittings shall meet the hydraulic pump manufacturer’s recommendations for pressure, size, and the type of hose used.

8.6.2.3.4 Where the hydraulic hose comes into contact with other surfaces, the hose shall be protected from chafing.

8.6.3* Fixed Auxiliary Engine–Driven Generators. If the generator is driven by a fixed auxiliary engine, it shall meet the requirements of 8.6.3.1 through 8.6.3.9.4.

8.6.3.1 The generator shall be installed so that fumes, vapors, heat, and vibrations do not enter the driving or patient compartment.

8.6.3.2* Generators rated at 8 kW or more shall be equipped with a high temperature automatic shutdown system and a low oil (pressure or level) automatic shutdown system.

8.6.3.3 The generator shall be installed in accordance with the generator manufacturer’s requirements for ventilation and service accessibility.

8.6.3.4 If the generator is installed in a compartment and the compartment doors shall be open during its operation, the generator shall be equipped with an interlock system to prevent its operation if the doors are not open, or the compartment shall be equipped with a high temperature alarm.

8.6.3.5 If the generator is installed in a compartment on a slide tray and the slide tray is to be in the extended or out position during operation, an interlock shall be provided to prevent operation unless the tray is in the correct position, or the compartment shall be equipped with a high temperature alarm.

8.6.3.6 Permanently installed generators shall have readily accessible engine oil drain provisions or piping to a remote location for oil changing.

8.6.3.7 If the generator is installed in a compartment on a slide tray and the compartment doors shall be open during its operation, an interlock system to prevent its operation if the doors are not open, or the compartment shall be equipped with a high temperature alarm.

8.6.3.8 Fuel System.

8.6.3.8.1 Fuel lines shall be protected from chafing at all wear points.

8.6.3.8.2 If the fuel source is shared with the ambulance engine, a separate fuel pickup system shall be provided that is arranged to ensure that the generator cannot utilize more than 75 percent of the fuel tank’s capacity.

8.6.3.9 Exhaust System.

8.6.3.9.1* The exhaust piping and discharge shall be located or shielded to prevent thermal damage to the ambulance or equipment.

8.6.3.9.2 The exhaust shall be piped to the exterior of the vehicle and discharged at a location away from any operator’s position.

8.6.3.9.2.1 The exhaust system for the generator shall comply with Section 5.6.

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

8.6.3.9.4 Silencing devices shall be provided and shall not create exhaust backpressure that exceeds the limits specified by the engine manufacturer.

8.6.4* Line Voltage Power Derived from the Ambulance Low Voltage Power Supply Systems. If the power source derives its input energy from the ambulance low voltage electrical system, it shall meet the requirements of 8.6.4.1 and 8.6.4.2.

8.6.4.1 The low voltage power supply system shall be installed in compliance with the requirements of Chapter 7.

8.6.4.2* The alternator and/or battery system shall be adequate to provide power for continuous operation for a minimum of 2 hours at full output.

8.6.5 Power Sources Requiring Elevated Engine Speed. If the power source requires the chassis engine to be operating at a specific fixed speed or a specific speed range, it shall meet the requirements of 8.6.5.1 through 8.6.5.3.

8.6.5.1 The main propulsion engine shall have a governor capable of maintaining the engine speed within the limits required by the power source to meet the frequency control, voltage control, and power output specifications.
8.7.3.4 Connected to an overcurrent protection device.

8.7.3.3 If there is not an overcurrent protection device at the power source, the conductors in the cord sized to carry a minimum of 115 percent of the nameplate amperage.

8.7.3.2 There shall be a single output connector cord with all of the conductors commensurate with their amperage capacities.

8.7.3.1 Circuit conductors shall be sized in relation to the power source requirements of 8.7.3.1 through 8.7.3.5.

8.7.2 Wiring for Portable Generator Installations. The generator shall comply with Article 445, “Generators,” of NFPA 70.

8.7.1 Any portable generator that can be operated while mounted on the ambulance shall be as follows:

1. Installed so that fumes, vapors, heat, excessive noise, and vibrations do not enter interior driving or crew compartments or damage the generator during operation
2. Have the exhaust outlet located so that exhaust is directed away from any operator station located on the ambulance and guarded to protect the operator
3. Installed in a location that directs the exhaust and heat at least 12 in. (300 mm) away from the fuel fill, oxygen system, entry doors, and ventilation inlets

8.7.2 If the portable generator is remotely mounted, it shall have a remote operator’s control station that shall provide a means for starting and stopping the generator and monitoring the same instrumentation as is required for fixed power sources.

8.7.3 Wiring for Portable Generator Installations. Wiring installed for the purpose of facilitating the distribution of power from a portable generator installation to fixed wiring on the ambulance shall conform to the additional requirements of 8.7.3.1 through 8.7.3.5.

8.7.3.1 Circuit conductors shall be sized in relation to the power source specification label rating and shall be protected by an overcurrent device commensurate with their amperage capacities.

8.7.3.2 There shall be a single output connector cord with all of the conductors in the cord sized to carry a minimum of 115 percent of the nameplate amperage.

8.7.3.3 If there is not an overcurrent protection device at the power source, the output connector cord shall not exceed 72 in. (1830 mm) in length and shall be connected to an overcurrent protection device.

8.7.3.4 The rating of an external main overcurrent protection device shall equal the rated amperage on the power source specification label or the next larger available size overcurrent protection device so recommended by the power source manufacturer.

8.7.3.5 If a connecting plug is required, it shall be sized in relation to the system and conform to NEMA configurations for plugs.

8.8 Transfer Switch Applications.

8.8.1 A transfer switch shall be required to isolate one power source from the other where a circuit(s) is intended to be supplied from more than one power source.

8.8.2 Transfer equipment, including transfer switches, shall operate such that all ungrounded conductors of one power source are disconnected before any ungrounded conductors of the second source are connected.

8.8.3 The neutral conductor shall be switched through the transfer switch.

8.9 Power Supply Assembly.

8.9.1 The conductors used in the power supply assembly between the output terminals of the power source and the main overcurrent protection device shall not exceed 12 ft (4 m) in length.

8.9.2 All power supply assembly conductors, including neutral and grounding conductors, shall have an equivalent amperage rating and shall be sized to carry not less than 115 percent of the amperage of the nameplate current rating of the power source.

8.9.3 If the power supply assembly connects to the vibrating part of a generator (not a connection on the base), the conductors shall be flexible cord or other fine-stranded conductors enclosed in metallic or nonmetallic liquidtight flexible conduit rated for wet locations and temperatures not less than 194°F (90°C).

8.10 Overcurrent Protection.

Manually resettable overcurrent devices shall be installed to protect the line voltage electrical system components.

8.10.1 Power Source Protection. A main overcurrent protection device shall be provided that is either incorporated in the power source or connected to the power source by a power supply assembly.

8.10.1.1 The size of the main overcurrent protection device shall not exceed 100 percent of the rated amperage stated on the power source specification label or the rating of the next larger available size overcurrent protection device, where so recommended by the power source manufacturer.

8.10.1.2 If the main overcurrent protection device is subject to road spray, the unit shall be housed in a Type 4-rated enclosure.

8.10.2 Branch Circuit Overcurrent Protection. Overcurrent protection devices shall be provided for each individual circuit and shall be sized at not less than 15 amperes in accordance with 240.4, “Protection of Conductors,” of NFPA 70.

8.10.2.1 Any panelboard shall have a main breaker where the panel has six or more individual branch circuits or the power source is rated 8 kW or larger.

8.10.2.2 Each overcurrent protection device shall be marked with a label to identify the function of the circuit it protects.

8.10.2.3 Dedicated circuits shall be provided for any large appliance or device that requires 60 percent or more of the rated capacity of the circuit to which it is connected, and that circuit shall serve no other purpose.

8.10.3 Panelboards. All fixed power sources shall be hardwired to a permanently mounted panelboard unless one of the following conditions exists:

1. All line voltage power connections are made through receptacles on the power source, and the receptacles are protected by integrated overcurrent devices.
2. Only one circuit is hardwired to the power source, which is protected by an integrated overcurrent device.

8.10.3.1 The panel shall be visible and located so that there is unimpeded access to the panelboard controls.

8.10.3.2 All panelboards shall be designed for use in their intended location.

8.10.3.3 The panel(s) shall be protected from mechanical damage, tool mounting, and equipment storage.

8.10.3.4 Where the power source is 120/240 volts, and 120-volt loads are connected, the ambulance manufacturer or line voltage system installer shall consider load balancing to the extent that it is possible.

8.11 Wiring Methods. Fixed wiring systems shall be limited to the following:

1. Metallic or nonmetallic liquidtight flexible conduit rated at temperatures not less than 194°F (90°C) with stranded copper wire rated for wet locations and temperatures not less than 194°F (90°C)
2. Type SOW, SOOW, SEOW, or SEOOW flexible cord rated at 600 volts and at temperatures not less than 194°F (90°C)

8.11.1 Electrical cord or conduit shall not be attached to chassis suspension components, water or fuel lines, air or air brake lines, oxygen lines, hydraulic lines, exhaust system components, or low voltage wiring and shall be arranged as follows:

1. Separated by a minimum distance of 12 in. (300 mm) from exhaust piping or shielded from such piping
2. Separated from fuel lines by a minimum distance of 6 in. (152 mm)

8.11.1.1 Line voltage wiring shall not be routed through the oxygen compartment.

8.11.2.1 A means shall be provided to allow “flexing” between the driving and crew compartment, the body, and other areas or equipment whose movement would stress the wiring.

8.11.3 Electrical cord or conduit shall be supported within 6 in. (152 mm) of any junction box and at a minimum of every 24 in. (600 mm) of run.

8.11.3.1 Supports shall be made of nonmetallic materials or of corrosion-resistant or corrosion-protected metal.

8.11.3.2 All supports shall be of a design that does not cut or abrade the conduit or cord and shall be mechanically fastened to the ambulance.

8.11.4 Only fittings and components listed for the type of cord or conduit being installed shall be used.
8.11.4.1 Where rigid metal conduit or intermediate metal conduit is terminated at an enclosure with a lock nut and bushing connection, two lock nuts shall be provided with one inside and one outside of the enclosure.

8.11.4.2 All cut ends of conduit shall be reamed or otherwise finished to remove rough edges.

8.11.5 Splices shall be made only in a listed junction box.

8.11.6 Additional Requirements for Flexible Cord Installations.

8.11.6.1* Where flexible cord is used in any location where it could be damaged, it shall be protected by installation in conduit, enclosures, or guards.

8.11.6.2 Where flexible cord penetrates a metal surface, rubber or plastic grommets or bushings shall be installed.

8.11.7 Wiring Identification.

8.11.7.1 Each line voltage circuit originating from the main panelboard shall be identified.

8.11.7.2 The wire or circuit identification either shall reference a wiring diagram or wire list or shall indicate the final termination point of the circuit.

8.11.7.3 Where pre-wiring for future power sources or devices exists, the unterminated ends shall be marked with a label showing their wire size.

8.12 Wiring System Components.

8.12.1 Only stranded copper conductors with an insulation rated for temperatures of at least 194°F (90°C) and wet locations shall be used.

8.12.1.1 Conductors in flexible cord shall be sized in accordance with Table 400.5(A) of NFPA 70.

8.12.1.2 Conductors used in conduit shall be sized in accordance with 310.15, “Ampacities for Conductors Rated 0–2000 Volts,” of NFPA 70.

8.12.1.3 Aluminum or copper-clad aluminum conductors shall not be used.

8.12.2 All boxes shall conform to and be mounted in accordance with Article 314, “Outlet, Device, Pull, and Junction Boxes; Conduit Bodies; Fittings; and Manholes,” of NFPA 70.

8.12.2.1 All boxes shall be readily accessible.

8.12.2.2 Boxes shall not be permitted behind welded or pop-riveted panels.

8.12.2.3 The maximum number of conductors permitted in any box shall be in accordance with 314.16, “Number of Conductors in Outlet, Device, and Junction Boxes, and Conduit Bodies,” of NFPA 70.

8.12.2.4* All wiring connections and terminations shall provide a positive mechanical and electrical connection.

8.12.3.1 Connectors shall be installed in accordance with the manufacturer’s instructions.

8.12.3.2 Wire nuts or insulation displacement and insulation-piercing connectors shall not be used.

8.12.4* Each switch shall indicate the position of its contact points (i.e., open or closed) and shall be rated for the continuous operation of the load being controlled.

8.12.4.1 All switches shall be marked with a label indicating the function of the switch.

8.12.4.2* Circuit breakers used as switches shall be “switch rated” (SWD) or better.

8.12.4.3 Switches shall simultaneously open all associated line voltage conductors.

8.12.4.4 Switching of the neutral conductor alone shall not be permitted.

8.12.4.5 Line voltage circuits controlled by low voltage circuits shall be wired through properly rated relays in listed enclosures that control all nongrounded current-carrying conductors.

8.12.5* Receptacles and Inlet Devices.

8.12.5.1 The patient compartment shall be furnished with a minimum of three (3) line voltage duplex receptacles conforming to NEMA 5-15.

8.12.5.2 Receptacles shall be near flush, vertically mounted.

8.12.5.3 All interior outlets shall be installed in accordance with 210.7, “Receptacles and Cord Conductors,” of NFPA 70.

8.12.5.4 Any receptacle shall be at least 12 in. (300 mm) from any oxygen outlet.

8.12.5.5 An indicator shall be located within each line voltage receptacle as a line monitor indicating a live (hot) circuit.

8.12.5.6 Wet and Dry Locations.

8.12.5.6.1 All wet location receptacle outlets and inlet devices, including those on hardwired, remote power distribution boxes, shall be of the grounding type, provided with a wet location cover, and installed in accordance with 406.8, “Receptacles in Damp or Wet Locations,” of NFPA 70.

8.12.5.6.2 All receptacles located in a wet location shall be not less than 24 in. (600 mm) from the ground.

8.12.5.6.3* Receptacles on off-road vehicles shall be a minimum of 30 in. (760 mm) from the ground.

8.12.5.7 All receptacles located in a dry location shall be of the grounding type and shall be at least 12 in. (300 mm) above the interior floor height.

8.12.5.8 No receptacle shall be installed in a face-up position.

8.12.5.9 The face of any wet location receptacle shall be installed in a plane from vertical to not more than 45 degrees off vertical.

8.12.5.10 Receptacle Label.

8.12.5.10.1 Each receptacle shall be marked with a label indicating the nominal line voltage (120 volts or 240 volts) and the current rating in amps of the circuit.

8.12.5.10.2 If the receptacle is dc or other than single phase, that information shall also be marked on the label.

8.12.5.11* All receptacles and electrical inlet devices shall be listed to ANSI/UL 498, Standard for Safety Attachment Plugs and Receptacles, or other recognized performance standards.

8.12.5.12 Receptacles used for dc voltages shall be rated for dc service.

8.13 Cord Reels.

8.13.1 All permanently mounted cord reels shall be rated for continuous duty and installed to be accessible for removal, cord access, maintenance, and servicing.

8.13.2 The power rewind cord reel spool area shall be visible to the operator during the rewind operation, or the reel spool shall be encapsulated to prevent cord from spooling off the reel.

8.13.3 Rollers or guides shall be provided, where required, to prevent damage to the cord at reel spools or compartment openings.

8.13.4 Rewind Provision.

8.13.4.1 Manually operated reels shall have a hand crank.

8.13.4.2 Power rewind-type reels shall have the control in a position where the operator can observe the rewinding operation.

8.13.4.3 If a reel is in an enclosure or out of direct view, the cord entry point to the enclosure shall be visible to the operator of the reel control.

8.13.4.4 The rewind control or crank shall not be more than 72 in. (1830 mm) above the operator’s standing position.

8.13.4.5 The rewind control shall be marked with a label indicating its function and shall be guarded to prevent accidental operation.

8.13.5* The reel shall be designed to hold 110 percent of the capacity needed for the intended cord length.

8.13.6* The wire size shall be in accordance with NFPA 70, Table 400.5(A), but in no case shall it be smaller than 12 AWG.

8.13.7* Electrical cord shall be Type SEOW, Type SOOW, or Type STOW.

8.13.8* A label that indicates the following information shall be provided in a visible location adjacent to any permanently connected reel:

1. Current rating
2. Current type
3. Phase
4. Voltage
5. Total cord length
8.13.9 Where a power distribution box is hardwired to the end of a cord that is stored on a fixed cord reel or other fixed storage means, the requirements in 8.13.9.1 through 8.13.9.6 shall apply.

8.13.9.1 The remote power distribution box shall be listed for use in a wet location.

8.13.9.2* The distribution box shall be as follows:
   (1) Protected from corrosion
   (2) Capable of being carried with a gloved hand
   (3) Designed to keep the exterior electrical components above 2 in. (51 mm) of standing water

8.13.9.3 Inlets, receptacles, circuit breakers, or GFCI devices shall not be mounted on the top surface of the horizontal plane.

8.13.9.4 Branch circuit breakers shall be installed in the remote power distribution box if the overcurrent device protecting the feed cord to the box is too large to protect the wiring supplying the devices plugged onto the distribution box.

8.13.9.5* Remote power distribution boxes shall have a light on the box to indicate the power is on.
   (1) The light shall be visible in a 360-degree plane from a minimum of 200 ft (60 m) in complete darkness.
   (2) The light shall be mechanically protected to prevent damage.

8.13.9.6 The hardwired portable cord connection to the box shall have strain relief and meet the intended usage requirements.

8.14 Scene Lighting Systems.

8.14.1 Where fixed scene lights are supplied, the requirements in 8.14.2 through 8.14.5 shall apply.

8.14.2 All scene lights shall be provided with a lens or a means for preventing damage from water spray and shall be listed for wet location usage.

8.14.3 Handle on Lights.
   (1) If the light is adjustable, a handle shall be provided.
   (2) The design of the light shall not allow the temperature of the handle to exceed 131°F (55°C).

8.14.4 The manufacturer of the device shall have the scene light tested by a nationally recognized testing laboratory and listed to ANSI/UL 153, Standard for Portable Electric Luminaires, or ANSI/UL 1598, Luminaires.

8.14.5 If manually operated floodlights are not operable from the ground, access steps and handrails that meet the requirements of Chapter 6 shall be provided to allow the user to reach the floodlights.

8.15 Appliance Accessibility and Fastening.

8.15.1 All electrical appliances shall be accessible for inspection, service, repair, and replacement without removal of permanent construction.

8.15.2 Appliances shall be fastened in accordance with the manufacturer’s directions.

Chapter 9 Test Methods

9.1 Ambulance Body Structure Test.

9.1.1 Roof Crush Test.
   (1) Support the ambulance on a rigid fixture independent of the vehicle suspension
   (2) Remove any components that extend upward from the vehicle roof
   (3) Measure and record the distance from the mounting surface to each of the four corners of the roof
   (4) Employ a rectangular force application plate fitted as near as possible to the contour of the ambulance roof
   (5) Position the force application plate so that it is centered on the roof
   (6) Close all ambulance doors
   (7) Load the application plate to 500 lb (227 kg) at a deflection rate less than 0.5 in. (13 mm) per second
   (8) Record elevation readings of all four corners of the roof
   (9) Load the application plate to 50 percent of the final load at a deflection rate less than 0.5 in. (13 mm) per second
   (10) Record elevation readings of all four corners of the roof
   (11) Load the application plate to 100 percent of the final load at a deflection rate less than 0.5 in. (13 mm) per second
   (12) Record elevation readings of all four corners of the roof
   (13) Verify that patient compartment doors are capable of being opened and closed
   (14) Remove load
   (15) Verify that patient compartment doors are capable of being opened and closed

9.1.2 Side Crush Test (Type I and Type III Only).
   (1) Place either side of the body on a rigid horizontal surface so that the body is entirely supported
   (2) Measure and record the distance from the mounting surface to each of the four top corners of the body side
9.2.1 The following actions shall be performed during the body door test:

1. Position the test structure or ambulance on a level, horizontal surface
2. Employ force application fixtures in such a manner that the opposing forces are supported by the body structure
3. Apply forces for 10 seconds in all required directions and/or positions after the installation of associated body door retention components
4. Apply forces for 10 seconds to a continuous hinge so that the load will be distributed equally from top to bottom
5. Apply forces for 10 seconds to individual (strap-type) hinges so that the load will be distributed proportionally on each hinge
6. Apply forces so that it will be equally distributed as near the latch or hinge as practical

9.2.2 The patient compartment shall be structurally complete but need not include interior panels or cabinet installation.

9.3 Oxygen Tank Retention System Static Test.

9.3.1 The following actions shall be performed during the oxygen tank retention system static test as shown in Figure 9.3:

1. Test the retention system in a substantially similar ambulance or mounted to a structure that is substantially similar to the ambulance floor
2. Employ a test fixture that simulates the cot for which the retention system is designed
3. Install the test fixture in the retention system in such a manner that will preclude contact friction with the floor or cabinet surfaces
4. Apply each force so that it passes through the location that corresponds to the center of gravity of a loaded patient cot
5. Apply the test force for 10 seconds in the fore, aft, side-to-side, and vertical directions relative to the direction of vehicle travel
6. Replace any damaged parts after each application of force

9.4 Patient Cot Retention System Static Test. The following actions shall be performed during the patient cot retention system static test:

1. Test the retention system in a substantially similar ambulance or mounted to a structure that is substantially similar to the ambulance floor
2. Employ a test fixture that simulates the cot for which the retention system is designed
3. Install the test fixture in the retention system in such a manner that will preclude contact friction with the floor or cabinet surfaces
4. Apply each force so that it passes through the location that corresponds to the center of gravity of a loaded patient cot
5. Apply the test force for 10 seconds in the fore, aft, side-to-side, and vertical directions relative to the direction of vehicle travel
6. Replace any damaged parts after each application of force

9.5 Low Voltage Electrical System Test.

9.5.1 The ambulance is low voltage electrical system shall be tested as required by this section, the test results shall be certified by the ambulance manufacturer, and the certified test results shall be delivered with the ambulance.

9.5.2 Tests shall be performed when the ambient air temperature is between 60°F and 110°F (15°C and 43°C).

9.5.3 Test Sequence.

9.5.3.1 The three tests defined in 9.5.3.2 through 9.5.3.4.4 shall be performed in the order in which they appear.

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

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

9.5.3.2 Reserve Capacity Test.

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

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

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

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

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

9.5.3.3 Alternator Performance Test at Idle.

9.5.3.3.1 The minimum electrical load test conditions as stated in 7.3.2.1.1 shall be activated with the engine running at idle speed.

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

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

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

9.5.3.4 Alternator Performance Test at High Idle.

9.5.3.4.1 The operational electrical load test conditions as stated in 7.4.1 shall be activated with the engine running at high idle.

9.5.3.4.2 The test duration shall be a minimum of 30 minutes.

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

9.5.3.4.4 An alarm sounded by excessive battery discharge, as detected by the warning system required in Chapter 7, or a system voltage of less than 11.8 volts dc for a 12-volt nominal system, 23.6 volts dc for a 24-volt nominal system, or 35.4 volts dc for a 42-volt nominal system for more than 120 seconds shall be considered a test failure.

9.5.4 Low Voltage Alarm Test.
9.5.4.1 The following test shall be started with the engine off and the battery voltage at or above 12 volts for a 12-volt nominal system, 24 volts for a 24-volt nominal system, or 36 volts for a 42-volt nominal system.

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

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

9.5.4.4 The test shall be considered a failure if the alarm does not sound in less than 140 seconds after the voltage drops to 11.70 volts for a 12-volt nominal system, 23.4 volts dc for a 24-volt nominal system, or 35.1 volts for a 42-volt nominal system.

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

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

9.6 Patient Compartment Sound Level Test.

9.6.1 This test shall be performed during the following environmental conditions:

1. Temperature not to exceed 95°F (35°C).
2. Humidity not to exceed 75 percent relative humidity
3. Wind velocity not to exceed 12 mph (19 km/hr)
4. Barometric pressure 29 in. Hg to 31 in. Hg (98.2 kPa to 104.9 kPa)

9.6.2 The following actions shall be performed during the patient compartment sound level test:

1. Measure sound level using a meter that meets requirements of the ANSI S1.4, Specification for Sound Level Meters, for Type II meters with the meter set to A for a weighing network, “fast” meter response
2. Suspend the microphone 23 in. (584 mm) above the vehicle floor, centered laterally and longitudinally on the expected center of the patient cot as it will be secured in the patient compartment.
3. Park ambulance on a concrete or asphalt surface, at a location so that no large reflecting surfaces, such as other vehicles, signboards, buildings, or hills are within 50 ft (15.2 m) of the vehicle being tested
4. Close all ambulance doors, windows, and vents
5. Run air conditioner and heater blower fans in patient compartment at the highest speed
6. Set vehicle transmission in neutral gear and set the engine speed to the rpm obtained by the ambulance when operating on level ground at 55 mph (88 km/hr)
7. Turn on all warning lights
8. Operate siren in the loudest mode
9. Measure and record the highest sound level
10. Decrease the engine speed to idle and then back to the 55 mph (88 km/hr) rpm
11. Measure and record the highest sound level
12. Repeat until two maximum sound levels within 2 decibels (db) of each other are recorded
13. Numerically average these two maximum sound level readings

9.7 Reserved.

9.8 Handrail Static Load Test. The following actions shall be performed during the handrail static load test:

1. Apply force to handrail at the midpoint between every location where the handrail fastens to the vehicle body structure and as near as possible to the ends of the handrail as shown in Figure 9.8(1)

2. (2) Apply the force perpendicular to the mounting surface
3. (3) Apply the force parallel to the mounting surface
4. (4) Apply the force diagonal to the mounting surface at an angle midway between the perpendicular and the parallel pulls as shown in Figure 9.8(4)
5. (5) Maintain each force application for 2 minutes

9.9* Line Voltage Electrical Systems Test.

9.9.1 The wiring and associated equipment shall be tested by the ambulance manufacturer or the installer of the line voltage system.

9.9.2* The electrical polarity of all permanently wired equipment, cord reels, and receptacles shall be tested to verify that wiring connections have been properly made.

9.9.3 Electrical continuity shall be verified from the chassis or body to all line voltage electrical enclosures, light housings, motor housings, light poles, switch boxes, and receptacle ground connections that are accessible to personnel in normal operations.

9.9.4 If the ambulance is equipped with a transfer switch, it shall be tested to verify operation and that all nongrounded conductors are switched.

9.9.5 Electrical light towers, floodlights, motors, fixed appliances, and portable generators shall be operated at their full rating or capacity for 30 minutes to ensure proper operation.

9.9.6* Certification Test of Power Source.

9.9.6.1 The ambulance manufacturer or installer of the power source shall perform a certification test on each power source.

9.9.6.2 The testing of any power source greater than 3 kW shall be witnessed, and the results of the tests of the power source shall be certified by an independent third-party certification organization.

9.9.6.3 Test Procedure.

9.9.6.3.1 The prime mover shall be started from a cold start condition, and the unloaded voltage and frequency shall be recorded.

9.9.6.3.2 The line voltage electrical system shall be loaded to at least 100 percent of the continuous rated wattage stated on the power source specification label.

9.9.6.3.3 Testing with a resistive load bank shall be permitted.

9.9.6.3.4 The power source shall be operated in the manner specified by the ambulance manufacturer as documented on instruction plates or in operation manuals.

9.9.6.3.5 The power source shall be operated at a minimum of 100 percent of the continuous rated wattage as stated on the power source specification label for a minimum of 2 hours.
9.9.6.3.5.1 The load shall be adjusted to maintain the output wattage at or above the continuous rated wattage during the entire 2-hour test.

9.9.6.3.5.2 The following conditions shall be recorded at least every 30 minutes during the test:

1. The power source output voltage, frequency, and amperage
2. The prime mover’s oil pressure, water temperature, and transmission temperature, if applicable
3. The power source hydraulic fluid temperature, if applicable
4. The ambient temperature and power source air inlet temperature

9.9.6.3.5.3 The following conditions shall be recorded once during the test for power sources driven by dedicated auxiliary internal combustion engines:

1. Altitude
2. Barometric pressure
3. Relative humidity

9.9.6.3.6 If the generator is driven by the chassis engine and the generator allows for operation at variable speeds, the chassis engine speed shall be reduced to the lowest rpm allowed for generator operation and the voltage and frequency shall be recorded.

9.9.6.3.7 The load shall be removed, and the unloaded voltage and frequency shall be recorded.

9.9.6.3.8 Voltage shall be maintained within ±10 percent of the voltage stated on the power source specification label during the entire test.

9.9.6.3.9 Frequency shall be maintained within ±3 Hz of the frequency stated on the power source specification label during the entire test.

9.10 Water Leak Test. This test shall be performed during the following environmental conditions:

1. Temperature above 40°F (4°C)
2. Wind velocity not to exceed 10 mph (16 km/hr)

9.10.2 The following actions shall be performed during the waterleak test:

1. Close all windows and doors
2. Turn off heating, ventilating, and air conditioning (HVAC) systems
3. Drench the entire roof, sides, front, and back of the vehicle evenly with water spray from a nozzle or combination of nozzles
4. Continue spraying until a minimum of 40 gal (151 L) of water has been used
5. Start engine and operate the cab and patient compartment ventilation systems at maximum ventilation rates
6. Continue spraying until a minimum of 40 gal (151 L) of water has been used
7. Inspect the interior of the cab and patient compartment for water leaks during the duration of the test
8. At the conclusion of the test, examine all exterior lights and exterior compartments for leakage

9.11 Equipment Temperature Test. The following actions shall be performed during the equipment temperature test:

1. Locate the test vehicle in an environmental chamber capable of maintaining a temperature within +/- 4°F (2°C)
2. Shut off all vehicle power
3. Open all patient compartment entry doors, cabinet doors, cab door windows, and exterior compartment doors
4. Maintain an air velocity over the vehicle of at least 5 mph (8 km/hr) throughout the entire test
5. Cool the chamber to 32°F (0°C) and soak the vehicle at this temperature for a minimum of 3 hours
6. Start the engine
7. Operate all vehicle systems for 1 hour while maintaining 32°F (0°C) chamber temperature
8. Shut off the engine
9. Heat the chamber to 95°F (35°C) and soak the vehicle at this temperature for a minimum of 3 hours
10. Start the engine
11. Operate all vehicle systems for 1 hour while maintaining 95°F (35°C) chamber temperature
12. Shut off the engine

9.12 Interior Climate Control Test. The following actions shall be performed during the interior climate control test:

1. Locate the test vehicle in an environmental chamber capable of maintaining a temperature within +/- 4°F (2°C)
2. Locate 3 thermocouples 7 in. (178 mm) off the floor along the patient compartment centerline and equally spaced from front to back
3. Locate 3 thermocouples 7 in. (178 mm) below the ceiling along the patient compartment centerline and equally spaced from front to back
4. Locate 3 thermocouples midway between the floor and the ceiling along the patient compartment centerline and equally spaced from front to back
5. Locate 3 thermocouples in the cab horizontally positioned 24 in. (600 mm) above the seat cushion and located 12 in. (300) in front of the headrest
6. Locate first and third thermocouples along the centerline of driver’s and passenger’s seats and center the second between the first and third
7. Turn off all vehicle power
8. Open all patient compartment entry doors, cabinet doors, cab door windows, and exterior compartment doors
9. Open engine hood
10. Maintain an air velocity over the vehicle of at least 5 mph (8 km/hr) throughout the entire test
11. Cool the chamber to 32°F ± 4°F (0° C ± 2°C) and soak the vehicle at this temperature for a minimum of 3 hours
12. Close all doors and hood with exception of partition doors (if present) and patient compartment/cab partition window (if present)
13. Set heaters in cab and patient compartment to maximum heating setting (maximum temperature, maximum blower speed, recirculating air)
14. Record the thermocouple temperatures
15. Shut off patient compartment dome lights
16. Start engine and maintain transmission in neutral or park and engine high idle on with a maximum engine speed of 1500 rpm
17. Record thermocouple temperatures at 5-minute intervals up to 30 minutes
18. Shut off the engine
19. Open all patient compartment entry doors, cabinet doors, cab door windows, and exterior compartment doors
20. Open engine hood
21. Heat the chamber to 95°F (35°C) with a minimum of 40-percent relative humidity and soak the vehicle at this temperature for a minimum of 3 hours
22. Close all doors and hood with exception of partition doors (if present) and patient compartment/cab partition window (if present)
23. Set air conditioners in cab and patient compartment to maximum cooling setting (maximum blower speed, coldest temperature setting, recirculating air)
24. Record the thermocouple temperatures
25. Shut off Patient compartment dome lights
26. Start engine and maintain transmission in neutral or park and engine high idle on with a maximum engine speed of 1500 rpm
27. Record thermocouple temperatures at 5-minute intervals up to 30 minutes
28. Shut off the engine
9.13 Reserved.

9.14 Engine Cooling System Test. The following actions shall be performed during the engine cooling system test:

1. Locate the test vehicle in an environmental chamber capable of maintaining a temperature within +/- 4°F (2°C) for 1 hour.
2. Turn off all vehicle power.
3. Open all patient compartment entry doors, cabinet doors, cab door windows, and exterior compartment doors.
4. Heat the chamber to 95°F (35°C) and soak the vehicle at this temperature for a minimum of 3 hours.
5. Start the engine.
6. Close all doors, hood, partition door (if present), and patient compartment/cab partition window (if present).
7. Maintain an air velocity over the vehicle of at least 5 mph (8 km/hr) throughout the entire test.
8. Set air conditioners in cab and patient compartment to maximum cooling setting (maximum blower speed, coldest temperature setting, recirculating air).
9. With all other ambulance equipment off, operate the engine at high idle for 1 hour.

9.15 Ambulance Main Oxygen System Test.

9.15.1 Pressure Test. The following actions shall be performed during the engine cooling system test:

1. Ensure that the ambulance temperature has stabilized in an environment between 34°F and 110°F (1°C and 43°C).
2. Charge the system with approximately 200 psi (1380 kPa) of test gas.
3. Close system valves to trap pressure in the lines that contain the vent valve.
4. Record system pressure with an accuracy of +0.1 psi (7 kPa).
5. Allow system to rest without disturbance for 2 hours.
6. Record system pressure.

9.15.2 Flow Test. The following actions shall be performed for the flow test:

1. Ensure that the ambulance temperature has stabilized in an environment between 34°F and 110°F (1°C and 43°C).
2. Charge the system with test gas regulated to 50 psi ± 2 psi (345 kPa ± 14 kPa).
3. Plug all outlets other than the one being tested.
4. Measure and record the flow of gas from each outlet using a flowmeter with an accuracy of ±1 L/min.
5. Check the electrical continuity between the oxygen system piping and the vehicle to verify that it is grounded.

9.16 Patient Compartment Lighting Level Test. The following actions shall be performed for the patient compartment lighting level test:

1. Prepare the ambulance or locate it in an environment to prevent light from penetrating into the patient compartment.
2. Remove the patient cot.
3. Start the engine.
4. Turn on dome lights to highest setting.
5. Measure and record the light intensity along the longitudinal centerline of the patient compartment floor every 10 in. (254 mm).
6. Turn on the lights that come on with the side entry door or rear entry door.
7. Measure and record the light intensity along the longitudinal centerline of the patient compartment floor every 10 in. (254 mm).
8. Measure and record the light intensity in the center of the side entry step well and record the reading.
9. Install the patient cot test grid shown in Figure 9.16(9), 17 in. (432 mm) above the patient compartment floor, centered laterally and longitudinally on the expected center of the patient cot as it will be secured in the patient compartment.
10. Measure and record the light intensity in the center of each 5 in² (322 mm²) area on the test grid.

9.17 Reserved.

9.18 Rear Stepping Surface Load Test. The following actions shall be performed during the rear stepping surface load test:

1. Support the ambulance or substantially similar structure to negate the effect of the vehicle suspension.
2. Apply vertical load on the stepping surface using a fixture that distributes the load over a circular area 5 in. (127 mm) in diameter.
3. Apply 500 lb (227 kg) of load to the lateral and longitudinal center of the stepping surface.
4. Record deflection during the load application.
5. Release the load.
6. Measure and record any permanent deformation after the load is released.
7. Apply 500 lb (227 kg) of load to the longitudinal center of the stepping surface as close to each of the lateral extremes as the test fixture will allow.
8. Record deflection during the load application.
9. Release the load.
10. Measure and record any permanent deformation after the load is released.

9.19 Reserved.

9.20 Reserved.

9.21 Aspirator System Test. The following actions shall be performed during the aspirator system test:

1. Ensure that the ambulance temperature has stabilized in an environment between 34°F and 110°F (1°C and 43°C).
2. Run the vehicle engine at high idle speed for duration of the test.

9.21.3 Vacuum Test. The following actions shall be performed during the vacuum test:

1. Install a 120 in. (3 m) length of transparent or translucent, nonkinking suction tubing on the collection bottle.
2. Install a vacuum-measuring instrument capable of an accuracy of ±5 mm Hg to measure the vacuum in the collection bottle.
3. Open the vacuum control and shutoff valve to their full open position.
4. Turn on vacuum pump.
5. Clamp or plug end of suction tubing.
6. Measure and record the vacuum 4 seconds after plugging the tubing.

9.21.4 Flow Test. The following actions shall be performed during the flow test:

1. Install a flow-measuring instrument capable of an accuracy of ±1 L/min to measure the flow in the suction tubing.
2. Open the vacuum control and shutoff valve to their full open position.
3. Turn on vacuum pump.
4. Measure and record the flow.
9.22 Reserved.

9.23 Reserved.

9.24 Perimeter Illumination Test. The following actions shall be performed during the perimeter illumination test:

1. Locate the ambulance in dark environment
2. Ensure that the vehicle batteries are fully charged
3. Record light intensity with a meter capable of measuring to an accuracy of ±0.01 fc
4. Construct a grid of test points off of the sides and rear of the test ambulance as shown in Figure 9.24(4)
   (a) Locate lines parallel with the exterior walls of the patient compartment 60 in. and 120 in. (1524 mm and 3048 mm) from the test unit
   (b) Intersect these lines with lines perpendicular to the exterior walls emanating from each corner and the mid-point of the patient compartment
   (c) Construct additional perpendicular lines emanating from the center of each scene light
5. Measure and record the light intensity at each point in the grid
6. Turn on all exterior scene lights
7. Measure and record the light intensity at each point 3 in. (76 mm) above the grid
8. Subtract the ambient light readings from the scene light readings

9.25 Occupant Head Clearance Zones Test.

9.25.1 The following actions shall be performed during the occupant head clearance zones test:

1. Construct a rigid rectangular test box 43 in. (1092 mm) high, 24 in. (457 mm) wide, and 15 in. (381 mm) deep
2. Place the test box in each seating position, centered laterally on the seat cushion, with the bottom edge resting against the seat back
3. Align the test box so that the sides of the box are perpendicular to the patient compartment floor

9.25.2 The maximum weight for the test fixture shall not exceed 60 lb (27 kg).

9.25.3 No permanent objects shall protrude into the test box zone.

Annex A Explanatory Material

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

A.1.4 It is not intended that this standard be applied retroactively to existing ambulances. However, if major renovations are made to an existing ambulance, it is suggested that the ambulance be brought into line with this standard as closely as possible.

A.1.6 Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). The liter, a unit that is outside of but recognized by SI, is commonly used in international fire protection. Table A.1.6(a) and Table A.1.6(b) provide U.S.-to-SI conversion factors and SI-to-U.S. conversion factors as an aid to the user. Table A.1.6(c) provides other conversion factors that could be useful to the reader. Table A.1.6(d) provides a list of the abbreviations used in this standard and their meanings.

<table>
<thead>
<tr>
<th>Table A.1.6(a) Conversion Factors: U.S. Customary Units to SI Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Customary Units</td>
</tr>
<tr>
<td>1 gallon per minute (gpm)</td>
</tr>
<tr>
<td>1 imperial gallon per minute (igpm)</td>
</tr>
<tr>
<td>1 pound per square inch (psi)</td>
</tr>
<tr>
<td>1 inch of mercury (in. Hg) at 60°F (15.6°C)</td>
</tr>
<tr>
<td>1 inch (in.)</td>
</tr>
<tr>
<td>1 foot (ft)</td>
</tr>
<tr>
<td>1 cubic foot (ft³)</td>
</tr>
<tr>
<td>1 square inch (in.²)</td>
</tr>
<tr>
<td>1 mile per hour (mph)</td>
</tr>
<tr>
<td>1 pound (lb)</td>
</tr>
<tr>
<td>1 horsepower (hp)</td>
</tr>
<tr>
<td>1 candlepower (cp)</td>
</tr>
<tr>
<td>1 pound per cubic foot (lb/ft³)</td>
</tr>
<tr>
<td>1 footcandle (fc)</td>
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<td>1 footlambert</td>
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<thead>
<tr>
<th>Table A.1.6(b) Conversion Factors: SI Units to U.S. Customary Units</th>
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<tbody>
<tr>
<td>SI Units</td>
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<td>1 square millimeter (mm²)</td>
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<td>1 kilogram (kg)</td>
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<tr>
<td>1 kilowatt (kW)</td>
</tr>
<tr>
<td>1 lumen</td>
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<tr>
<td>1 kilogram per cubic meter (kg/m³)</td>
</tr>
<tr>
<td>1 lux (lx)</td>
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<tr>
<td>1 candela/m²</td>
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</table>
Table A.1.6(c) Other Useful Conversion Factors

<table>
<thead>
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<th>Abbreviation</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>degree (degrees)</td>
</tr>
<tr>
<td>ac</td>
<td>alternating current</td>
</tr>
<tr>
<td>C</td>
<td>Celsius</td>
</tr>
<tr>
<td>cd</td>
<td>candela(s)</td>
</tr>
<tr>
<td>dc</td>
<td>direct current</td>
</tr>
<tr>
<td>EMSP</td>
<td>emergency medical services provider</td>
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<tr>
<td>F</td>
<td>Fahrenheit</td>
</tr>
<tr>
<td>fc</td>
<td>footcandle(s)</td>
</tr>
<tr>
<td>ft</td>
<td>foot (feet)</td>
</tr>
<tr>
<td>gpm</td>
<td>gallon(s) per minute</td>
</tr>
<tr>
<td>hp</td>
<td>horsepower</td>
</tr>
<tr>
<td>in.</td>
<td>inch(es)</td>
</tr>
<tr>
<td>in. Hg</td>
<td>inch(es) of mercury</td>
</tr>
<tr>
<td>kg</td>
<td>kilogram(s)</td>
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<tr>
<td>km/hr</td>
<td>kilometer(s) per hour</td>
</tr>
<tr>
<td>kW</td>
<td>kilowatts(s)</td>
</tr>
<tr>
<td>L</td>
<td>liter(s)</td>
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<tr>
<td>L/min</td>
<td>liter(s) per minute</td>
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<tr>
<td>lx</td>
<td>lux</td>
</tr>
<tr>
<td>m</td>
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<td>millimeter(s)</td>
</tr>
<tr>
<td>mph</td>
<td>mile(s) per hour</td>
</tr>
<tr>
<td>NH</td>
<td>National Hose</td>
</tr>
<tr>
<td>psi</td>
<td>pound(s) per square inch</td>
</tr>
<tr>
<td>rms</td>
<td>root mean square</td>
</tr>
<tr>
<td>V</td>
<td>volt(s)</td>
</tr>
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</table>

Table A.1.6(d) Abbreviations Used in This Standard

<table>
<thead>
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<th>Abbreviation</th>
<th>Term</th>
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<tbody>
<tr>
<td>1 bar</td>
<td>100 kilopascals (kPa)</td>
</tr>
<tr>
<td>1 kilopascal (kPa)</td>
<td>0.01 bar</td>
</tr>
<tr>
<td>1 foot (ft) of water</td>
<td>0.433 pound per square inch (psi)</td>
</tr>
<tr>
<td>1 imperial gallon (gpm)</td>
<td>1.22 gallons per minute (gpm)</td>
</tr>
<tr>
<td>1 metric ton (mton)</td>
<td>1000 kilograms (kg)</td>
</tr>
</tbody>
</table>

### A.3.2.1 Approved
The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence that the system employed by the listing organization to identify a listed product.

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

### A.3.2.4 Listed
The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

### A.3.3.1 Substantially Similar Ambulance
It is not practical to test every production vehicle to validate performance compliance. The substantially similar definition allows those requirements that call for a test on a substantially similar ambulance to be performed once, rather than on every production vehicle. An ambulance in which what is being compared applicable to the test being considered for an ambulance in which like areas are compared.

For chassis-related tests, substantially similar refers to an ambulance with a chassis that employs the same make and engine model. For patient compartment–related tests, substantially similar refers to an ambulance to make where the relevant construction methods and configuration are comparable.

### A.3.3.13 Contractor
The contractor might not necessarily manufacture the fire apparatus or any portion of the fire apparatus but is responsible for the completion, delivery, and acceptance of the entire unit.

### A.3.3.17 Electronic Siren
Varied types of warning sounds can be produced by electronic sirens, such as a siren, yelp, or simulated air horn.

### A.3.3.26 Grade
A 45-degree slope is equal to a 100-percent grade.

### A.3.3.37 Loose Equipment
Such equipment may include, but not be limited to, medicines, first-aid supplies, oxygen tanks, child seats, and personal damage.

### A.3.3.42 Optical Source
An optical source can consist of a single optical element or a fixed array of any number of optical elements whose geometric positioning relative to each other is fixed by the manufacturer of the optical source and is not intended to be modified.

### A.3.3.65.1 Curb Weight
The curb weight includes such items as the chassis; cab; body; batteries; spare tire; jack; tire changing tools; and any other permanently attached or dedicated equipment along with a full complement of fuel, lubricants, and coolant.

### A.3.3.66.1 Gross Axle Weight Rating (GAWR)
It is a requirement of the National Highway Traffic Safety Administration (NHTSA) that the GAWR be posted in the vehicle on a permanently affixed label. The axle system includes, but is not limited to, the axle, tires, suspension, wheels, frame, brakes, and applied engine torque.

### A.3.3.66.3 Gross Vehicle Weight Rating (GVWR)
It is a requirement of the National Highway Traffic Safety Administration (NHTSA) that the GVWR of a vehicle be posted in the vehicle on a permanently affixed label. The GVWR can be equal to or less than the sum of the front GAWR and the rear GAWR. The in-service weight or gross vehicle weight should always be equal to or less than the GVWR.

### A.4.6.9 Drawings
Drawings should be included in the test report where they will assist in documenting the configuration of the components or systems being tested. Drawing details can include views of the entire vehicle where appropriate as well as material sizes, thicknesses, welds, fasteners, adhesive coverage, and so forth of the critical regions that would be established as “minimums” for the respective location and function of the tested component or system.

### A.4.8.1 The engine compartment and the underside of the vehicle are not considered areas of normal nonmaintenance operation.

### A.4.9.2 All required signs, instruction plates, and labels should be highly visible and placed on the vehicle where they are not subject to damage from wear and tear.

### A.4.10.1 The attachment of electric, air, hydraulic, and other control lines and hoses should be with removable mechanically attached fastening devices. The attachment of such equipment with adhesive or glue-on clamps or clips has been found to be inadequate for long-term performance on ambulances. The use of plastic ties to bundle wire harnesses and hose is permissible, but ties should not be used to attach such items to a cab, body, frame, or other major structure.

### A.4.11.2 The purchaser should determine the types of grades the ambulance will be expected to operate on when it is in stationary operation. The occasional exposure to grades in excess of that required by this standard while on routine service would be expected to happen.
The vehicle might require special lubrication systems for engines and other modifications to ensure that it will not be damaged by operation on the increased grades.

A.4.11.3 This standard specifies various temperature ranges for the ambulance or ambulance systems based on their use. While the ambulance as a whole is required to operate satisfactorily in low temperatures, it is not crucial that the engine-starting capability be as low as the ambient temperature. Since most operations in cold climates will keep working ambulances in a garage or will use an engine block heater. Components or systems in the interior of the ambulance do not need to function at extremely low ambient temperatures since the interior of the ambulance will be maintained at higher temperatures by the HVAC system. The purchaser should consider the climate that the ambulance will operate in and specify temperatures outside these minimum standard ranges if appropriate.

The interior of the ambulance patient compartment should be maintained at a minimum temperature of 50°F (10°C) when the ambulance is prepared for immediate response. The purchaser should consider how this will be accomplished. If the ambulance will not be housed in a heated facility, then other means may be required to ensure that this requirement is met. This requirement does not apply to ambulances that are fully operational but being held in reserve or ambulances that are not fully operational.

A.4.12.4 Although this standard recognizes the need for the ambulance to be able to accelerate to a high speed while traveling on public roads, caution should be taken with regard to how fast the ambulance can travel.

Where the ambulance has to operate off paved roads, all-wheel drive, a two-speed rear axle, an auxiliary transmission, an automatic transmission, or any combination of these might enhance the ambulance’s off-road capability.

A.4.15 It is important for the purchaser and the contractor to agree on the format in which the documentation is to be delivered. It is also important that the purchaser consider the long-term ramifications of changing media technology if electronic format is used for delivery of the documentation. Software and hardware will need to be maintained over the years to utilize electronic documentation.

A.4.15.2 It is critical that the purchaser provide the manufacturer the equipment inventory and mounting locations for equipment on the ambulance. This information should include existing equipment and estimated future equipment to be carried. The projections of total equipment payload and mounting locations are essential for proper engineering of a new ambulance. It is the responsibility of the purchaser to properly load the ambulance and place equipment to comply with the GVWR, the front-to-rear weight distribution, and the right-to-left load balance requirements of this standard.

A.4.16.2.3 Suppliers of components and equipment installed or supplied by the contractor often supply operations and maintenance documents with those components or equipment. This standard requires that the contractor deliver these documents to the purchaser. The purchaser should specify if multiple copies of these documents are required.

A.4.16.3.1 The label shown in Figure 4.16.3.1 is a suggested format. Deviations in dimensions are acceptable.

A.5.1.3.2 It is important for ambulance drivers to understand the height and weight of the vehicle compared to their personally owned vehicles. It is also important that this information be accurate. If anything is added above the roofline height as delivered, the plate should be changed to reflect the new height. Suggested wording for the plate is shown in Figure A.5.1.3.2.

When manufactured, this vehicle was:
XX ft YY in. High
XX ft YY in. Long
ZZZZ lb GVWR

Changes in height since the apparatus was manufactured shall be noted on this plate by the fire department.

Figure A.5.1.3.2 Vehicle Height and Weight Plate.

A.5.2 For weight distribution measurement and calculation methods payload determination subtract the total curb weight of the completed vehicle from the GVWR. Any permanently attached, optional items of equipment specified by the customer are to be included in the curb weight of the completed vehicle. Any other items of optional equipment (i.e., not permanently attached and/or removable) are to be included in the payload requirement.

A.5.2.2 The projections of total equipment payload and mounting locations are essential for proper engineering of a new ambulance. The purchaser of the ambulance should maintain the side-to-side loading requirement in 5.2.2 as equipment is loaded or installed on the ambulance.

The percentage difference in side-to-side tire load should be calculated as shown in the following formula:

\[
\frac{\text{Heavier weight - Lighter weight}}{\text{Total weight}} \times 100 = \text{Percent difference}
\]

A.5.4.1 An increase in engine speed provides increased alternator output, increased engine cooling, increased air conditioner output, and increased output or performance from other devices that derive their power from the chassis engine.

A.5.5.1 Where local environmental extremes exist, that is, high humidity and temperatures or extreme low temperatures, the purchaser should state specifically under what environmental conditions the ambulance is expected to operate.

A.5.7.3 Purchasers of ambulances should also consider equipping the ambulance with an auxiliary braking system. Ambulances commonly make repeated stops from high speeds that cause rapid brake lining wear and brake fade, sometimes leading to accidents.

Auxiliary braking systems are recommended on ambulances that are exposed regularly to steep or long grades, operate in congested areas where repeated stops are normal, or respond to a high number of emergencies.

Examples of auxiliary braking systems include engine retarders, transmission retarders, exhaust retarders, and driveline retarders. These devices have various levels of effectiveness on braking. In addition, the systems can be activated by various means and settings, both automatic and manual in operation. The purchaser should carefully evaluate all auxiliary braking systems based on vehicle weight, terrain, duty cycle, and many other factors.

Some auxiliary braking devices should be disconnected when the ambulance is operated on slippery surfaces. Follow the auxiliary braking device manufacturer’s recommendations for proper instructions.

A.5.8.1 The angle of approach or departure affects the road clearance of the vehicle going over short, steep grades such as would be found in a driveway entrance, crossing a high crowned road at a right angle, or off-road service. Too low an angle of approach or departure will result in the vehicle scraping the ground. Figure A.5.8.1 shows the method of determining the angle of departure. The angle of approach (front of vehicle) is measured in the same fashion.

In Figure A.5.8.1, the line AT represents the circumstance in which the rear bumper is the determining lowest point. The line BT represents a circumstance in which the rear bumper is not the lowest point (in this case, the lowest point is a fuel tank). The angle of departure is shown as XA or XB. To determine the angle of departure, complete the following steps:

1. Place a thin steel strip against the rear of the tires where they touch the ground or stretch a string tight from one rear tire to the other at the rear of where they touch the ground
2. Determine the lowest point (the bumper, fuel tank, or other equipment or component) that would make the smallest angle of departure

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The ratio of $V/H$ is the tangent of the angle of departure. If this ratio is known, the angle of departure can be determined from a table of trigonometric functions of angles or from a math calculator.

A.5.8.2 Traction control features can include positive locking differential, limited slip differential, electronic traction control, and so forth.

A.5.9.5 Proper tire inflation is essential to the safe operation of any motor vehicle. Proper inflation improves the handling characteristics and minimizes the risk of rollover.

A.5.10 Electronic stability control (ESC) uses a steering wheel position sensor, a vehicle yaw sensor, a lateral accelerometer, and individual wheel brake controls in conjunction with the antilock brake system (ABS). The system tracks the direction that the driver intends to steer and uses brake application at individual wheels to help straighten out the vehicle. This system greatly enhances the safety of the vehicle, and the purchaser should consider adding ESC to the ambulance if available as an option or consider purchasing an ambulance configuration that offers ESC.

A.5.11.1 The purchaser may wish to specify front and/or rear tow hooks or tow eyes to be attached to the frame structure to allow towing (not lifting) of the ambulance without damage.

A.5.11.2.8.7 The intent of step size and placement requirements is to ensure that the foot is supported when it is placed on the step in the normal climbing position. In some cases the most natural method of mounting a step may not be perpendicular to the leading edge (common on chassis where it would be natural not to open the door completely to the 90-degree point and enter the door opening at a diagonal from the rear). In these cases, the clearance measurement can be taken diagonally across the step in the natural direction of climb.

A.5.14 Purchasers may wish to consider specifying that all mirror head faces be independently adjustable from the driver’s position when this feature is available from the OEM.

A.6.7.5 Unless otherwise specified by the purchaser to delete walkthru or to specify or approve alternate door opening dimensions, the door opening shall be at least 17 in. (43 cm) wide and 46 in. (117 cm) high and shall provide an aisle between the compartments. The door shall have at least a 150 in.² (968 cm²) transparent, shatterproof viewing panel in the center section at the driver’s eye level. The door should be secured cab side self-latching device in the open and closed positions.

A.6.9.7 The requirement of 6.9.7 does not apply to both rear doors – only the primary door.

A.6.16 The following measuring guidelines are for cabinets and compartments: [Consider making this a separate annex. The amount of info and level of detail would be best suited as an annex]

1. Cabinet depth: The dimension from the cabinet inside back wall to the outside cabinet face.
2. Compartment depth: The dimension from the compartment inside back wall to the outside compartment face.
3. Door OD: The door overall outside thickness (dimension).
4. Depth ID: The actual interior depth either measured or figured by subtracting the Door OD from the cabinet or compartment measured depth.
5. Height ID: The dimension from the interior bottom surface to the interior surface of the cabinet or compartment top.
6. Width ID: The dimension from one interior surface to the next interior surface of the cabinet or compartment.
7. Sliding window track: The track used for sliding cabinet windows.
8. Sliding cabinet windows: The sliding doors used on interior cabinets.

The area of an interior cabinet with hinged doors [shown in Figure A.6.16(b)] is determined as follows:

1. Measure from the back of the door to the face of the door and record dimension for Door OD.
2. Measure from the back of the rear wall to the cabinet face and record dimension for cabinet depth.
3. Subtract the Door OD from the cabinet depth for Depth ID.
4. Measure from cabinet interior wall to wall and record dimension for Width ID.
5. Measure from the interior top to bottom and record dimension for Height ID.
6. Multiply Height ID × Width ID × Depth ID and divide by 1728 for cubic feet.

Figure A.6.16(a) Measurements of Interior Cabinets with Sliding Doors or Roll-up Doors.

The area of an interior cabinet with sliding doors or roll-up doors [shown in Figure A.6.16(a)] is determined as follows:

1. Measure from the back of the rear wall to the back of the sliding window track and record that dimension for Depth ID.
The area of an exterior compartment with hinged doors [shown in Figure A.6.16(c)] is determined as follows:

1. Measure from the back of the door to the face of the door and record dimension for Door OD
2. Measure from the back of the rear wall to the cabinet face and record dimension for cabinet depth
3. Subtract the Door OD from the cabinet depth for Depth ID
4. Measure from cabinet interior wall to wall and record dimension for Width ID
5. Measure from the interior top to bottom and record dimension for Height ID
6. Multiply Height ID \times Width ID \times Depth ID and divide by 1728 for cubic feet

NOTE: Subtract any notches for spring shackles or fuel systems from the total to get the correct total cubic feet.

Figure A.6.16(c) Measurements for Exterior Compartments with Hinged Doors.

A.6.19 Each disposable container should be mounted inside a fixed container capable of withstanding a moderate crash without dispersing its contents into the patient compartment.

A.6.21.2 It is not recommended that SCBA packs be stored in the patient compartment because of the risk of contamination. If the purchaser does specify SCBA storage in seat backs, then they should meet the requirements found in NFPA 1901.

A.6.21.3.1 The ultimate mission of any ambulance is to safeguard the health and welfare of the patient being transported. This mission fails if the ambulance does not arrive safely. To this end it is essential that the ambulance is driven in a safe manner and that all occupants are seated and belted while the vehicle is in motion. During emergency responses, emergency medical personnel could be inclined to take more risks than usual and to skip basic vehicle safety precautions. To encourage safe practices, ambulance operation management should consider employing some method of monitoring the driving habits of the ambulance personnel. Several methods of monitoring compliance of all safety precautions by personnel in the vehicle including available live video monitoring, video recording, and vehicle data recording. Any monitoring method should include monitoring of the use of seat belts, and an indication of how carefully the ambulance is being driven.

Purchasers may wish to consider specifying seat belt colors such as bright red or bright orange. Bright belt colors are easier to see on videos or by observation through the window when enforcing seat belt use compliance.

Seat belt design is critical to safety during a crash. Seat belts should conform to FMVSS 210 S4.3.3.1 which requires that the lap portion of the belt in any designated seating position does not constrain the occupant high across the belly.

A.6.23 Some chassis used on ambulances may not be capable of providing independent control of the HVAC units between the cab and the patient compartment. Purchasers may wish to consider chassis selection if this is a feature that is important in the climate where the ambulance will be used.

A.6.25 Retro-reflective contour stripes of any color affixed to the front, rear, and side surfaces of the ambulance to outline the vehicle profile may provide additional conspicuity. The purchaser may wish to consider including this in the specification.

A.6.25.1 If the purchaser specifies exterior doors, consideration should be given to affixing the stripe of reflective material in a location that will not be obscured or lost when the doors are open.

A.7.1 This chapter defines the requirements for alternators, batteries, load management, and instrumentation to detect incipient electrical system failure. The intent is to require an electrical system that will operate the ambulance using power supplied by the alternator, shed nonessential electrical loads where necessary, and provide early warning of electrical failure in time to permit corrective action.

A.7.2.1.1 The 125-percent requirement for wiring and circuits is intended to provide reduced voltage drop over wire rated based on ampacity due to heating. In low voltage wiring, voltage drop becomes a problem before the thermal limit of current carrying capacity of a wire is reached. This requirement also ensures that the circuit protection will prevent damage to the wire in the event of a short or an overload. It is not the intent of this requirement to have the final-stage manufacturer replace the chassis manufacturer’s original equipment wiring to meet the 125-percent requirement. It is also not the intent of this requirement to have electrical accessories purchased by the ambulance manufacturer rewired to meet the 125-percent requirement. Electrical device manufacturer–supplied wiring can be used to the point where it connects to the ambulance manufacturer’s installed wiring.

A.7.2.2.9 It is the intent of 7.2.2.9 to provide a unique means of identifying a wire or circuit to prevent confusing it with another wire or circuit if electrical system repairs become necessary. If a color coding scheme is used instead of some other unique identification, that color should not be reused for a wire in any unrelated circuits within the same harness. However, 7.2.2.9 covers low voltage wiring only and does not apply to shielded cables commonly used for communication purposes or wiring used in line voltage circuits.

A.7.3.2 The minimum alternator size is developed using the loads required to meet the minimum continuous electrical load. Most ambulances will actually have loads exceeding the minimum requirements of this standard. The purchaser should review the maximum current output of the alternator versus the load study supplied for the ambulance from the manufacturer for on-scene and responding modes.

A.7.4.1(10) The purchaser should analyze the electrical loads that need to be maintained to fulfill the mission of the ambulance and define those loads for the manufacturer of the ambulance. The purchaser needs to understand, however, that there is a limit to the output capacity of an alternator system on the ambulance’s engine and that this standard requires that the ambulance be capable of maintaining the minimum continuous electrical load under the conditions defined in 7.3.2. When that load is exceeded and larger alternators are not available, the purchaser and the manufacturer need to work together to determine how to reduce the minimum continuous electrical load to that which can be sustained under the conditions defined in 7.3.2.

A.7.4.3 The unexpected shutdown of an ambulance during a response can place patients in mortal danger and seriously affect the life-saving ability of the crew. With computer-controlled engines and transmissions as well as other controls, an electrical system failure could result in an immediate and total shutdown of the ambulance. The low voltage monitoring system is intended to provide an early warning of an impending electrical failure and provide enough time to permit operator intervention.

A.7.5.1 Electrical loads on ambulances frequently exceed the alternator capacity. Exceeding alternator capacity will result in the deep discharge of the ambulance batteries. Automatic load management is intended to protect the batteries and electrical system from needless damage while maintaining the operation of essential devices.

It is important that the priority of all managed loads be specified by the purchaser so that, as electrical loads are disconnected from the ambulance’s electrical systems, they are shed in an order least likely to affect emergency operations. Optical warning devices in excess of the minimum required in this standard can and should be load managed.

A.7.6 Batteries usually have two ratings: “cold cranking amperes,” which determine the size engine that can be started, and “reserve capacity,” which provides a measure of the total power that can be provided at a much lower constant rate of discharge. Ambulance batteries should be sized to have enough cold cranking ampegrage and reserve capacity to restart the engine after being substantially discharged.
A.7.6.3.3 Overheating of a battery will cause rapid deterioration and early failure. Evaporation of the water in the battery electrolyte can also be expected.

A.7.6.5 The power cord from the onboard charger or battery conditioner should be plugged only into a receptacle protected by a ground-fault circuit interrupter (GFCI) at the shoreline origination point.

A.7.6.7 The purchaser might want to add an illuminated “Module Disconnect” switch that could control all electrical loads for the module. The illuminated switch could control a solenoid. If the switch is specified, it should be located in the driver’s compartment, be legibly marked, illuminated when “ON,” and rated to carry at least 125 percent of the circuit’s maximum current, unless it operates a solenoid. If the switch operates a solenoid then the solenoid should be rated for 125 percent of the circuit’s maximum current. The module disconnect switch or device should be different in feel from other switches or be physically isolated from them.

A.7.8 SAE J551/1 provides test procedures and recommended levels to assist engineers in the control of broadband electromagnetic radiation and in the control of radio interference from equipment installed on the ambulance. Adherence to the recommended levels will minimize the degradation effects of potential interference sources in the communication equipment or other devices susceptible to electromagnetic interference.

Procedures are included to measure the radiation from a single device or the entire ambulance. Compliance could be determined through actual tests on the completed ambulance or predictions based on tests previously conducted on similarly equipped ambulance. If compliance certification is required, it should be so indicated in the ambulance specifications.

A.7.9.1 The upper-level optical warning devices provide warning at a distance from the ambulance and the lower-level optical warning devices provide warning in close proximity to the ambulance. (See Figure A.7.9.1.)

**FIGURE A.7.9.1 Upper- and Lower-Level Optical Warning Devices.**

A.7.9.3 Under typical conditions, the specified optical warning system provides effective, balanced warning. In some situations, however, the safety of the ambulance can be increased by turning off some warning devices. For example, if other vehicles need to pass within close proximity to the parked ambulance, the possibility of distracting other drivers can be reduced if the headlights and lower-level warning lights are turned off. In snow or fog, it might be desirable to turn off forward-facing strobes or oscillating lights to reduce visual disorientation of the ambulance driver.

The intent of the warning light system is to provide full coverage signals through the operation of a single master switch when the ambulance is either responding or blocking the right-of-way. There is no intent to prevent the use of lower levels of warning when the ambulance driver believes such reductions are appropriate, given the vehicle’s mission, the weather, or other operational factors. Additional switches downstream of the master switch can be specified by the purchaser to control individual devices or groups of devices.

Purchasers might want to specify traffic flow–type lighting such as amber directional indicators for use in alerting approaching motorists of blocked or partially blocked highways.

A.7.9.10 When a component such as a flasher or power supply is used to operate more than one optical source, the optical sources should be connected so that the failure of this component does not create a measurement point without a warning signal at any point in any zone on either the upper or lower level. Although a single optical source can be used to provide warning signals into more than one zone, the possibility of total signal failure at a measurement point is increased when the same flasher or power supply is used to operate multiple optical sources, each providing signals into more than one zone.

A.7.9.12 Flashing headlights are used in many areas as warning lights and provide an inexpensive way to obtain additional warning to the front of the ambulance. Daylight flashing of the high beam filaments is very effective and is generally considered safe. Nighttime flashing could affect the vision of oncoming drivers as well as make driving the ambulance more difficult.

In some jurisdictions, headlight flashing is prohibited or limited to certain types of emergency vehicles. If flashing headlights are employed on ambulance, they are to be turned off when the ambulance headlights are on. They should also be turned off along with all other white warning lights when the ambulance is in the blocking mode.

Steady burning headlights are not considered warning lights and can be illuminated in the blocking mode to light the area in front of the ambulance. Consideration should be given, however, to avoid shining lights into the eyes of oncoming drivers.

A.7.9.13 The minimum optical warning system should require no more than an average of 40 amperes for the operation of the upper-level and lower-level devices in the blocking mode. On ambulance whose length requires midship lights, no more than 5 amperes of additional current should be required for the operation of each set of midship lights. Optical warning systems drawing more than 40 amperes might necessitate modification of the electrical system specified in Section 7.3 in order to supply the additional power required.

See Figure A.7.9.13(a) and Figure A.7.9.13(b) for illustrations of an optical warning system on a large ambulance.

**FIGURE A.7.9.13(a) Front and Left Sides of Ambulance with Optical Warning System.**

**FIGURE A.7.9.13(b) Rear and Right Sides of Ambulance with Optical Warning System.**

A.7.9.13.5 The zone totals reflect the combined performance of the individual optical warning devices oriented as intended on the ambulance when viewed along the perimeter of a circle of 100 ft (30.5 m) radius from the geometric center of the ambulance. The zone total is the sum of the optical power of all optical sources projecting signals of permissible color into the zone as measured at 5-degree increments along the horizontal plane passing through the optical
The calculation of zone totals assumes that all optical sources are mounted at the geometric center of the ambulance. With the optical center of each optical source oriented as installed, the optical power contributed by every optical source is determined at each measurement point. The zone total is the sum of the optical power at the 19 measurement points in the zone. The upper- and lower-level optical sources are calculated independently.

The engineering basis of Section 7.9 permits both the design and the certification of an optical warning system by mathematical combination of the individual test reports for any number of optical warning devices of different color, flash rate, optical source, and manufacturer. Using the test reports provided by the device manufacturer, the contribution of optical energy from each optical source is determined for every data point. The total candela-seconds per minute of optical energy is determined at each point, and then the zone totals are calculated and compared to Table 7.9.13.5.

A.7.9.14 The minimum optical warning system should require no more than an average of 35 amperes for the operation of the devices in the blocking mode.

A.7.9.16 In a few cases, a manufacturer might wish to type certify an actual measurement of the optical warning system on an ambulance. Certification of the actual measurement of the performance of the optical warning system is made with each optical source either mounted on the ambulance or on a frame duplicating the mounting of the device on the ambulance. The performance of the system can be directly measured along the perimeter of a circle with a 100 ft (30.5 m) radius from the geometric center of the ambulance. Each optical warning device used should be certified by its manufacturer as conforming to all the requirements of this standard pertaining to mechanical and environmental testing of photometric performance of the system should be performed by qualified personnel in a laboratory for such optical measurements.

The test voltages and other details should be as called for in this standard for the photometric testing of individual optical warning devices. The elevation of the photometer, however, could be set at the elevation that maximizes the performance of the upper-level devices and at a second, different elevation that maximizes the performance of the lower-level devices.

With the optical center of each device oriented as installed, the sum of the actual value of the optical power contributed by every optical source is then determined at each measurement point. The zone total is the sum of the optical power at the 19 measurement points in the zone. Measurements are made to determine all the optical requirements of this standard, including the optical power at each of the required measurement points, the zone totals at the horizontal plane passing through the optical center, and the zone totals at 5 degrees above and 5 degrees below the horizontal plane passing through the center. Any upper-level warning devices mounted above the maximum height specified by the manufacturer(s) should be tested to demonstrate that at 4 ft (1.2 m) above level ground and 100 ft (30.5 m) from the mounted device, the optical energy exceeds 50 percent of the minimum required at the horizontal plane passing through the optical center.

If the purchaser wishes to have the sirens controls within convenient reach of persons riding in both the right and left front seat positions, that should be specified. In some applications, multiple control switches might be necessary to achieve convenient reach from the two positions. If other signal devices, such as an additional siren, bell, air horn(s), or buzzer are desired, the type of device and its control location also should be specified.

A.7.11.6.1 The user might want to consider a map light or additional task lighting in the cab.

A.7.11.6.3 The purchaser might want to add “checkout lights” that can be controlled by a timer or switch wired directly to the batteries. These “checkout” lights are usually fluorescent lights wired to the line voltage shoreline and can be wired so that the ambulance ignition or battery switch need not be turned on.

A.7.11.6.3.2 The purchaser should be aware that, even if technically considered “white” through industry standard color tolerances, care should be taken to insure interior lighting fixtures, primarily patient dome lights, maintain a uniform color hue (measured by color temperature in degrees Kelvin), across all like installed light fixtures.

Experience indicates a color temperature nearest “daylight” (6500°K) may be preferred, though commonly achievable only with LED or fluorescent light sources. Lower cost incandescent and halogen patient dome lights typically fall within the “warmer” range of 2500°K to 3500°K. Care should be taken when selecting lighting fixtures to avoid wide variations in lighting temperature within the patient treatment area of the patient compartment.

A.7.12.1 Electronic displays that are visible in all ambient light and that project narrative information can be used in lieu of discrete, colored, indicator/warning lights, provided the projected message is at least as visible as the basic required warning light.

A.7.13 The purchaser might wish to add camera(s) at the sides or rear of a vehicle with cab monitoring screens or automatic vehicle-stopping devices that sense an obstruction at the rear of the vehicle. In addition, angled backup lights mounted in the wheel well areas will provide additional scene lighting for personnel who might be at the side of the vehicle or lighting of folding tanks or other obstacles on the side of the ambulance. Any such devices will improve safety while vehicles are backing.

A.7.15.2 The purchaser should specify the appropriate features to accommodate their communication equipment, including but not limited to metal ground planes, grounding, coaxial cable, and antenna placement.

A.8.2.2.1 The purchaser should specify the location on the apparatus for the power inlet. Consideration should be given to placement of the power inlet so that it disconnects if the apparatus is moved forward or an auto-eject device can be utilized. The shoreline and circuit breaker should be sized for the anticipated electrical load.

A.8.2.5.3 Portable line voltage electrical equipment added by the ambulance service should also be listed and utilized only in accordance with the manufacturer’s instructions.

A.8.2.6.4 Although a splash shield will lessen the amount of road spray that reaches the generator, it will not protect the generator if the ambulance is driven through deep water. Care should also be taken if the ambulance is driven off-road, because a splash shield is not a skid pan and will not protect the generator from physical abuse.

A.8.3.1 It is important that all metal parts of the ambulance and the electrical system be bonded to the vehicle chassis. Any electrical boxes, conduits, or fixtures that are not permanently mounted to the metal body should be bonded to the protective ground wire. It is especially important that the metal light fixtures or housings of pole lights, light towers, and portable lights be grounded through the protective ground wire. NFPA 70, National Electrical Code, requires the following:

The normally non-current-carrying metal parts of equipment and the equipment grounding conductors at terminals of the receptacles are connected to the generator frame. [70:250.34(A),(2), 250.34(B)(3)]

Use of a ground rod on an ambulance is not recommended. If one is used, the requirements of NFPA 70, Article 250, should be followed. These requirements are difficult to achieve in a portable application.

Supplying a building electrical system from an ambulance is not recommended, because it commits the ambulance to the task and requires a significantly different grounding scheme, at least while being used for this application, in accordance with NFPA 70, 250.20, “Alternating-Current Systems to Be Grounded”; 250.30, “Grounding Separately Derived Alternating-Current Systems”; and other applicable sections of NFPA 70. In this situation, the grounding allowed by 250.34 is no longer applicable.

A.8.3.1.4 This refers to the protectitive ground (green wire), not the “neutral” wire. The ground is the chassis/body of the vehicle, not a connection to an earth ground.

A.8.4 Ground-fault circuit interrupters (GFCIs) are intended to provide protection from electrical shock, but experience in the emergency services has pointed out the following considerations about using them:

1. GFCIs integrated into outlets or circuit breakers or as stand-alone devices can be used.

2. Where possible, GFCIs should be located at the end of cords (i.e., in the distribution box at the end of a cord reel) to reduce tripping associated with long cord lengths and to put the reset function closer to the user.

3. GFCIs might not be compatible with 120/240-volt 4-wire cord reels frequently used in emergency services unless the GFCI is located at the end of the cord.

4. Many plugs and receptacles used in the emergency services are twist lock instead of standard nonlocking household plugs and receptacles, and in these cases, the GFCIs integrated with an outlet cannot be used, requiring circuit breaker GFCIs or standalone GFCIs.

A.8.5.4.1 The 120°F (49°C) requirement is for air inlet temperature to the power source. The completed ambulance is required to operate at an ambient temperature of 110°F (43°C). The difference of only 10°F (6°C) is difficult to achieve due to heat produced by the ambulance. The installer should take this temperature into consideration in selecting a location for the power source. If the ambulance is intended to operate at high temperatures, the purchaser may want to specify a larger nameplate rating on the generator and derate it to allow for a higher temperature capability. Consult with the power source manufacturer for more information on extended temperature range operation. In the testing required in Chapter 9, the ambient and air inlet temperatures are recorded, giving a measure of the temperature difference in actual operation.
The following factors could be relevant to power source testing, depending on the type of power source:

1. **Sampling.** The selection of test unit(s) should be representative of the construction and settings for units that will be supplied to the ambulance manufacturer. The standard does not require that all production units be tested; however, the power source manufacturer should test as needed to maintain confidence in its declaration of the continuous duty rating for all production.

2. **Clearances, cooling, and ventilation.** Testing should be conducted at the worst-case clearance (usually minimum clearance or minimum compartment size) and worst-case ventilation conditions (minimum inlet/outlet dimensions and maximum inlet/outlet restrictions) specified in the literature. If not in the literature, the power source manufacturer’s declaration should indicate the clearances, compartment size, and ventilation that are applicable to the declared continuous duty rating.

3. **Test duration.** “Continuous” ratings are usually established by tests run until thermal stabilization is achieved. A minimum test of 2 hours, matching the ambulance test duration indicated in Section 9.9, is recommended.

4. **Air inlet temperature.** Power sources should be tested in a chamber or room where the air temperature supplied to all inlet ducts (radiators, engine induction, windings, heat sinks, and so forth), and the air surrounding the test unit, is maintained at 120°F (49°C).

5. **Barometric pressure.** Pressure (air density) varies with changes in altitude and weather. Its effect is generally greatest on engines, where it affects combustion and cooling efficiency. There is a lesser effect on wound machines due to cooling only. To show compliance with the 2000 ft (600 m) requirement, a test in a chamber simulating 2000 ft (600 m) would be ideal, but it is not expected. Alternatively, connecting more or less than the rated load can be used to simulate/demonstrate that the engine is capable of the power required for rated output at 2000 ft (600 m). (Several standards’ organizations, such as SAE and ISO, have standards that describe how to compute load/output correction factors for barometric pressure.)

6. **Fuel temperature.** Fuel supply for the test should be stabilized at 120°F (49°C) before testing. Increases in fuel tank temperature that can occur as a result of fuel returned to the tank should be controlled so as to provide a result that is representative of expected fuel temperature conditions for the ambulance.

7. **Intake and exhaust restrictions, accessories, hydraulic pumps, and reservoir.** Components and accessories that might reduce engine power available for electrical output or that consume electrical output from the power source should be installed and be of the type used for the model that will be ordered for ambulance use, or their effect should be separately determined and reflected in the certified output.

8. **Break-in.** Acceptance of a reduced output rating until completion of an in-use break-in period is subject to the prior agreement of the ambulance manufacturer, who might request test evidence. When applicable, the reduced output amount and duration of the break-in period should be indicated in the power supply literature.

9. **Voltage and frequency.** Tests should be run while maintaining the ±10 percent voltage and ±3 Hz frequency required by 8.4.2.1. Furthermore, settings for voltage and frequency should be representative of production units.

10. **Engine speed and hydraulic flow/pressure.** The engine speed and/or hydraulic flow and pressure ranges indicated in the power source’s literature should be used to verify that the declared ratings are achievable.

11. **Hydraulic fluid temperature.** The entire hydraulic power supply system, including hydraulic fluid piping and reservoir, should be located within a test chamber where temperature is controlled to maintain 120°F (49°C). Hydraulic fluid reservoirs should be stabilized at the ambient air test temperature [120°F (49°C)] prior to the testing.

12. **Component and material temperatures.** Although not specified in the standard, when a power supply designed for light-duty use in open air is proposed for fixed ambulance use, the power source manufacturer should evaluate the components to determine whether they will operate within their rated or design temperature limits.

A.8.5.7.3 The instrumentation should be protected from vibration, which can lead to false readings. Particular attention should be paid to reed-type frequency indicators. Digital electronic instrumentation should be selected that incorporates sample times and intervals that accurately report system performance under varying conditions.

A.8.5.9 The indicator lights and interlocks specified in this section are minimums. Some manufacturers or users might choose to add additional indicator lights or interlocks.

A.8.5.9.3 Generators are operated from the side, top, front, or rear of the ambulance, and stationary operation requires that no power is applied to the wheels while operating. Therefore, it is essential that any generator system controls that shift the ambulance out of the road mode of operation to place the generator system in operation be equipped with a means to prevent disconnection of the control from its set position in the power generation mode.

A.8.6.1 A PTO generator system typically consists of a propulsion engine, a controller to regulate the propulsion engine’s speed (if required), an appropriate PTO arrangement, drivetrain components, a generator, and other miscellaneous parts.

Where possible, the generator PTO system should be prevented from engaging if engine speed is above idle.

PTO gear ratios and engine governor components should be selected and matched to provide an engine speed high enough to maintain rated performance of the alternator and air-conditioning system (if provided). Engine speed should be high enough to maintain rated performance of the low voltage electrical system. Continuous excessive engine speed will result in premature generator drivetrain component failure and unnecessary fuel consumption.

The purchaser should consider specifying a means to automatically disconnect the generator or reduce engine speed to idle in the event of engine overspeed.

A.8.6.2 A hydraulic generator system generally consists of a variable displacement hydraulic pump deriving its power from the propulsion engine, a controller to regulate the hydraulic fluid flow rate, a hydraulic motor driving the generator, hydraulic fluid cooler, reservoir, and other miscellaneous parts.

All hydraulic generator systems have a window of operation (speed range). When selecting the power output of the hydraulic generator system, its speed range should be compared to the operating window of the ambulance’s engine and the PTO ratios available. By selecting the hydraulic generator system and PTO ratio to match the application, electrical power can be provided over a wide operating range.

The selected PTO should have a gear ratio that will allow the widest possible range of engine speeds without overspeeding the hydraulic pump.

Where possible, engagement of the generator PTO system should be prevented if engine speed is above idle.

A.8.6.2.1 The means can be a mechanical, hydraulic, or electronic device.

A.8.6.3 Engine-driven generator systems use an internal combustion engine close-coupled to a generator. Some installations are capable of producing power while the ambulance is in motion. Generators used in these applications should be specifically designed for mobile applications. Remote generator controls in the driving compartment should be considered and specified if desired.

A.8.6.3.2 The purchaser should consider the following additional remote instruments where a prime mover, other than the propulsion engine, is used to drive a generator:

1. Oil pressure gauge and low pressure indicator light and audible alarm
2. Engine temperature gauge and high temperature indicator light and audible alarm

The purchaser might want to specify a high temperature indicator to help troubleshoot automatic shutdowns.

A.8.6.3.9.1 Emissions from exhaust discharge pipes should be directed away from any tools or equipment, because such emissions contain an oily substance that could make the tools difficult to handle and possibly dangerous to use.

A.8.6.4 Brief descriptions of several different types of systems follow. All of these systems can overload the low voltage electrical system and cause the load management system to terminate the generation of line voltage. As a result, the amount of line voltage power that can be supplied at any given time is totally dependent on the other, higher priority demands placed on the low voltage system.

**Dynamic Power Inverter.** A dynamic power inverter converts alternator output power to 120 volts ac (or 120/240 volts ac). Power is electronically inverted to ac. Usually the largest system of this type is 7500 watts. Voltage and frequency control are typically very good. These types of systems are suited to providing electric power while the ambulance is in motion.

**Static Power Inverter.** A static power inverter converts 12-volt to 14-volt dc power to 120-volt ac (or 120/240-volt ac) power. Power is electronically inverted to ac. Usually the largest system of this type is 2000 watts. Voltage and frequency control are typically very good. These types of systems are suited to providing electric power while the ambulance is in motion.

**Motor-Driven Generators.** A motor-driven generator system converts 12-volt dc power to 120-volt ac (or 120/240-volt ac) power. The 12-volt dc motor drives an ac generator. Typical power ratings are less than 1600 watts.
and frequency control are less precise than some of the other systems available. These types of systems are suited to providing electric power while the ambulance is in motion.

Transformers. Transformer systems convert energy from the alternator, which is then rectified to 120-volt dc power. Typical installations provide 1000 watts. Output voltage is directly dependent on input voltage. Input voltage is dependent on engine and alternator speed.

In most cases, other power sources that do not draw power from the low voltage system are preferable.

A.8.6.2 In order to provide adequate power, it can be necessary to provide a means to advance engine speed as described in 8.6.5.

A.8.6.5.3 Operations in conjunction with any other component driven off the ambulance’s engine could require special or alternate interlock systems.

A.8.6.6 Devices that produce modified sine waves can be less expensive than devices that produce pure sine waves. Power from electric utilities and most traditional mechanical generators are close to a pure sine wave. A modified sine wave output is satisfactory for many types of equipment but can cause problems with some types of equipment, including the following:

(1) Some computer and electronic equipment
(2) Some fluorescent lights with electronic ballasts
(3) Some tools with variable speed motor controls
(4) Some battery chargers
(5) Some medical equipment
(6) Some other equipment

The purchaser should identify what equipment is intended to be powered from the power source and verify with the equipment manufacturers that the equipment is compatible with modified sine wave power sources before specifying such a power source.

A.8.7 Portable generator systems are generally designed with an integral fuel tank and controls in one modular package. This allows the system to be picked up and transported to a remote location from the ambulance. Generators designed for portable use should be accessible for removal. These generators are generally not suited for “enclosed” compartment operation or should be mounted on a slide-out tray for adequate ventilation. Such installations require interlocks or a high temperature alarm to ensure that the generator is operated in a slide-out condition.

The generator performance specifications should be evaluated carefully to ensure that the required level of performance can be met. Article 445, “Generators,” of NFPA 70, National Electrical Code, requires that overcurrent protection be provided on portable generators.

A.8.9.3 Where the wire could be exposed to temperatures above 194°F (90°C), higher temperature-rated wire should be used.

A.8.10.3.4 Similar fixed loads should be paired on opposite legs of the power source where practical. If pairs of receptacles are provided on the same side of the ambulance or on the front or rear of the ambulance, they should be connected to opposite legs of the power source. If two 120-volt cord reels are provided, they should be connected to opposite legs of the power source. 120/240-volt cord reels should always be connected to both legs of the power source.

A.8.11 Where the wire could be exposed to temperatures above 194°F (90°C), higher temperature-rated wire should be used.

A.8.11.6.1 Locations in which flexible cord might be damaged include but are not limited to compartment walls and floors, exposed outside areas, and exposed interior areas near equipment or walkways.

A.8.12.3 Common connectors and terminations that comply with these requirements include but are not limited to the following:

(1) Welded or brazed connectors
(2) Crimped connectors
(3) Soldered connections that are mechanically secured before soldering
(4) Screw-type positive pressure connectors
(5) Ring terminals
(6) Hooks
(7) Upturned spade
(8) Crimped-on pins

A.8.12.4 The following switch terminology can be helpful in understanding the different types of switches:

(1) One Pole (1P) or Single Pole (SP). A switch device that opens, closes, or changes connections in a single conductor of an electrical circuit.
(2) Two Pole (2P) or Double Pole (DP). A switch device that opens, closes, or changes connections in both conductors of the same circuit.
(3) Two Circuit (2 CIR). A switch device that opens, closes, or changes connections in a single conductor of two independent circuits.
(4) Single Throw (ST). A switch that opens, closes, or completes a circuit at only one of the extreme positions of its actuator.
(5) Double Throw (DT). A switch that opens, closes, or completes a circuit at both extreme positions of its actuator.
(6) Normally Open (NO). A switch in which one or more circuits are open when the switch actuator is at its normal or rest position.
(7) Normally Closed (NC). A switch in which one or more circuits are closed when the switch actuator is at its normal or rest position.

Switches are rated for the type of load they are designed to control. Switch ratings include the following:

(1) Resistive
(2) Inductive
(3) Horsepower (i.e., motor loads)
(4) Tungsten (i.e., incandescent lamp loads)
(5) Alternating current
(6) Direct current

The amperage rating of a given switch is dependent on the type of load. In particular, switches used to control dc circuits should have the appropriate dc rating.

A.8.12.5.3 The purchaser should specify the number and location of receptacles that are needed to operate the devices to be powered by the system. The purchaser should specify the NEMA number (if applicable), manufacturer, and style of the receptacles desired. For other than NEMA-type receptacles, the purchaser should additionally specify the wire configuration.

A.8.12.5.6.3 If the off-road ambulance is to ford water, the receptacle distance should be increased above 30 in. (750 mm). The purchaser should review the proposed height for any receptacles on the ambulance and specify a higher mounting height if desired.

A.8.12.5.11 While NEMA configurations as defined in NEMA WD 6, Wiring Devices — Dimensional Requirements, are recommended to promote compatibility of equipment during mutual aid operations, other configurations are in use and have been adopted by various ambulance services.

Acceptable NEMA-type plug and receptacle configurations for various ac voltage and current ratings are shown in Figure A.8.12.5.11.

The letter “R” following the configuration number indicates a receptacle, and the letter “P” denotes a plug. For example, the nonlocking, 15-ampere, ground-receptacle found in most homes is configuration 5-15R and accepts a three-prong plug in the configuration of 5-15P.

Locking-type plugs and receptacles are designed to prevent accidental disconnection when subjected to moderate pull-apart loads. Neither locking nor nonlocking connectors are designed to withstand the loads that can be created when pulling long cords up buildings and stairs.

(See Figure A.8.12.5.11 on the following page.)
### NONLOCKING PLUGS AND RECEPTABLES

<table>
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<tr>
<th>Ampere</th>
<th>Receptacle</th>
<th>Plug</th>
<th>Receptacle</th>
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<td>5-15P</td>
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<td>5-20P</td>
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<td>14-60R</td>
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### LOCKING PLUGS AND RECEPTABLES

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**Figure A.8.12.5.11 NEMA WD-6, Wiring Devices—Dimensional Requirements. (Source: National Electrical Manufacturers Association.)**
A.8.13.5 A suggested minimum capacity of a reel is at least 100 ft (30 m) of cord rated to carry 20 amperes at 120 volts ac. When sizing the reel, extra capacity should be provided whenever multiple receptacles are attached to the cord stored on the reel.

A cord reel to supply a single 120-volt circuit requires three collector rings and three conductors in the cord, for line, neutral, and ground. If the power source has 120/240-volt outputs, as most power sources do, a second equivalent circuit with the same rating requires only one additional conductor because the neutral and ground can be common to both circuits. Thus, with approximately 25 percent more reel space and cord cost, the cord reel can supply twice the number of lights or other loads.

A.8.13.6 Table A.8.13.6 lists the suggested cord size for cord reels based on the desired circuit ampacity and the cord length. All cord reels with one or more outlets should be rated at 15 amperes or greater.

<table>
<thead>
<tr>
<th>Cord Length</th>
<th>50 ft (15 m)</th>
<th>100 ft (30 m)</th>
<th>150 ft (45 m)</th>
<th>200 ft (60 m)</th>
<th>250 ft (75 m)</th>
<th>300 ft (90 m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit Ampacity (amperes)</td>
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<td>12</td>
<td>12</td>
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</table>

For heavy loads such as large smoke fans and hydraulic rescue tool power plants, the purchaser should consider 240 volt units instead of 120-volt units. This will allow the use of smaller cords and reels. For example, a 200 ft (60 m) reel to supply a hydraulic rescue tool (HRT) power plant that draws 15 amperes at 240 volts would require 12-AWG wire. The same power unit in a version to run on 120 volts would draw 30 amperes and would require 8-AWG wire.

Cord reels for three-phase power or other specialized applications should be designed with the assistance of a qualified electrical engineer.

A.8.13.7 The purchaser may want to specify that the cord on the reel be provided with a disconnect means within 18 in. (457 mm) from the reel for cord removal if the cord is 8 AWG or smaller. A disconnect makes it easier to replace damaged cord or to use the cord to extend another cord, although it reduces the capacity of the reel and makes it harder to coil the cord on the reel.

A.8.13.8 The purchaser might want to color code the cord or cord reel to identify the voltage.

A.8.13.9.2 It might be advantageous to specify a remote power distribution box that has a provision for hanging the unit from a door or ladder.

A.8.13.9 The lamps used in this application should be rough-service type. Scene lighting around the remote power distribution box can be provided with an integral, mechanically protected light fixture.

A.8.13.9.5.1 For increased visibility, reflective tape can be applied to the distribution box.

A.9.4(6) Damaged parts can include hooks, antlers, or side bars. Rotation or deformation of retention mechanisms does not constitute failure.

A.9.5.1 The purchaser might wish to have the entire low voltage electrical system and warning device system certified by an independent third-party certification organization.

A.9.9 The purchaser should consider the range of temperatures in which the power source is to be operated. If extreme conditions are anticipated, the purchaser should specify the test conditions that are desired.

A.9.9.2 The purchaser should check the polarity of the wiring in a building prior to interconnecting the ambulance-mounted electrical system to the electrical system in a building.

A.9.9.6 It is important that the power source meet the purchaser’s requirements for output. Power sources may be advertised with power ratings for operating conditions that are more favorable than the conditions that might be encountered in ambulance use. Some power sources are advertised at peak output or intermittent duty rates and not the continuous duty output required for ambulances. The power source manufacturer and ambulance manufacturer might need to establish a reduced rating that is appropriate for ambulances. The standard calls for two steps. The power source manufacturer provides a declared rating for 120°F (49°C) air inlet temperature and 2000 ft (600 m) altitude for the minimum clearance and ventilation indicated on the declaration (see 8.5.10). Then the ambulance manufacturer verifies that the rating printed on the power source specification label can be attained during the line voltage load test (see 9.2.7).

### Generator Set Rating

Auxiliary engine-powered generator sets are the type of power source most likely to require a reduction from advertised ratings, and generator set literature usually provides rating correction factors for altitude and temperature. These factors could be based on standards for engines, such as ISO 3046-1, Reciprocating internal combustion engines — Performance — Part 1: Declarations of power, fuel and lubricating oil consumptions, and test methods — Additional requirements for engines for general use; and SAE J1349, Engine Power Test Code — Spark Ignition and Compression Ignition — Net Power Rating; standards for generators, such as NEMA MG 1, Motors and Generators; or manufacturer testing. As an example of how altitude and temperature affect output capability, consider a typical 10 kW generator set with 0.8 generator efficiency and naturally aspirated diesel engine that is rated at 500 ft (150 m) and 85°F (30°C) for continuous operation without overload or reserve capacity. ISO 3046-1 indicates a factor of -2.1 percent per 10°F (5.5°C) ambient increase, and a -2.6 percent per 1000 ft (300 m) altitude increase. Generator output is also affected by temperature [about -0.3 percent per 10°F (5.5°C)] and altitude (small and ignored in this example). There is also an effect from combining engine and generator into a generator set due to each heating the other. This may require an additional factor of -1 to -4 percent per 10°F (5.5°C), depending on the effectiveness of the cooling system and temperature (the factor increases with increasing temperature). Altogether, these factors suggest the 10 kW generator set in this example is capable of about 8.8 kW at the maximum temperature of 110°F (43°C) and altitude of 2000 ft (600 m) specified in the standard. Another way to view this result is that an 11.4 kW generator set would be required to provide 10 kW at 110°F (43°C) and 2000 ft (600 m).

Where there is concern that installation or operational circumstances could cause power source intake air to heat above 120°F (49°C) or where the flow of cooling, induction, or exhaust air is more restricted than what is allowed by the manufacturer’s literature, advance consultation with the power source manufacturer(s) could help in the selection of a power source that will pass the ambulance test with an output that meets the purchaser’s needs. Also, weather, like altitude, can affect air density and thus engine and generator set output.

The combined effect of altitude and weather is reported as barometric pressure on local weather reports. Low barometric pressure will reduce engine and generator set output capability. High barometric pressure (usually clear cold days) will increase engine and generator set output capacity.
Other Power Source Types. Some output correction factors described in the
generator set example apply to other types of power sources, depending on
circumstances. For example, PTO and hydraulically driven generators also rely
on engine power, but the engine will usually have substantial reserve power,
so increased altitude or temperature will not affect their power supply rating.
Regardless, best practice for longest life and lowest maintenance is to provide
unrestricted airflow at the lowest temperature.

A.9.15.2(4) For the purpose of this test, 110 L/min of breathing air or dry
nitrogen is considered equivalent to 100 L/min of oxygen.

Annex B Informational References

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

B.1 Referenced Publications.

B.1.1 NFPA Publications. National Fire Protection Association, 1
Battery March Park, Quincy, MA 02169-7471. NFPA 70, National Electrical


B.1.2 Other Publications. (Reserved)

B.1.2.1 ISO Publications. International Organization for Standardization, 1,
ch. De la Voie-Creuse, Case postale 56, CH-1211 Geneva 20, Switzerland.
ISO 3046-1, Reciprocating internal combustion engines — Performance —
Part 1: Declarations of power, fuel and lubricating oil consumptions, and test
methods — Additional requirements for engines for general use

B.1.2.2 NEMA Publications. National Electrical Manufacturers Association,

NEMA MG 1, Motors and Generators, ______.


B.1.2.3 SAE Publications. Society of Automotive Engineers, 400

SAE J551/1, Performance Levels and Methods of Measurement of
Electromagnetic Compatibility of Vehicles, Boats (up to 15 m), and Machines
(16.6 Hz to 18 GHz), 2006.

SAE J1349, Engine Power Test Code — Spark Ignition and Compression
Ignition — Net Power Rating, ______.

B.2 Informational References.


B.3 References for Extracts in Informational Sections.