NFPA® 1917

Standard for Automotive Ambulances

2013 Edition

NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization

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NFPA® 1917

Standard for

Automotive Ambulances

2013 Edition

This edition of NFPA 1917, *Standard for Automotive Ambulances*, was prepared by the Technical Committee on Ambulances and acted on by NFPA at its June Association Technical Meeting held June 11–14, 2012, in Las Vegas, NV. It was issued by the Standards Council on August 9, 2012, with an effective date of August 29, 2012.

This edition of NFPA 1917 was approved as an American National Standard on August 29, 2012.

Origin and Development of NFPA 1917

In October 2008, the Standards Council, after receipt of a request from the Technical Committee on Automotive Fire Apparatus for the development of a standard for ambulances, approved the establishment of a Technical Committee on Automotive Ambulances. The Committee developed this first edition of NFPA 1917, *Standard for Automotive Ambulances*, which establishes the minimum requirements for the design, performance, and testing of new automotive ambulances used for out-of-hospital medical care and patient transport.

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

Committee Scope: This Committee shall have primary responsibility for documents on the design and performance of ambulances used to provide patient care and transport under emergency conditions.

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NFPA 1917

Standard for

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex B. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

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

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 remounted 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, *Standard for Automotive Fire Apparatus*, or NFPA 1906, *Standard for Wildland Fire Apparatus*
(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 (AHJ) to demonstrate equivalency.

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

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.

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

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

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

NFPA 1906, *Standard for Wildland Fire Apparatus,* 2012 edition.

2.3 Other Publications.

2.3.1 AMECA Publications. Automotive Manufacturers Equipment Compliance Agency, 1025 Connecticut Avenue, NW, Suite #1012, Washington, DC 20036.

AMECA Compliance Handbook for GSA and SAE Warning Lamp Systems, 2010.

2.3.2 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036, www.ansi.org.

ANSI S1.4, *Specification for Sound Level Meters*, 2006.

ANSI Z535.4, *Product Safety Signs and Labels,* 2007.

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

ASTM D 4956, *Standard Specification for Retroreflective Sheeting for Traffic Control,* 2009.

ASTM E 661, *Standard Test Method for Performance of Wood and Wood-Based Floor and Roof Sheathing Under Concentrated Static and Impact Loads*, 2009.

2.3.4 IPC Publications. IPC, 300 Lakeside Drive, 309 S, Bannockburn, IL 60015, www.ipc.org.

IPC A-610D, Acceptability of Electronic Assemblies, 2005.

2.3.5 ISO Publications. International Organization for Standardization, 1, ch. de la Voie-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.

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

SAE J156, *Fusible Links*, 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 J553, *Circuit Breakers*, 2004.

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 J576, *Plastic Material or Materials for Use in Optical Parts Such as Lenses and Reflex Reflectors of Motor Vehicle Lighting Devices*, 2010.

SAE J578, *Color Specification*, 2006.

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

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

SAE J689, *Approach, Departure, and Ramp Break over Angles*, 2009.

SAE J845, *Optical Warning Devices for Authorized Emergency, Maintenance, and Service Vehicles*, 2007.

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

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

SAE J1330, *Photometry Laboratory Accuracy Guidelines*, 2007.

SAE J1690, *Flashers*, 1996.

SAE J1849, *Emergency Vehicle Sirens*, 2008.

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

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

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

SAE J2420, *COE Frontal Strength Evaluation — Dynamic Loading Heavy Trucks*, 2003.

SAE J2422, *Cab Roof Strength Evaluation — Quasi-Static Loading Heavy Trucks*, 2003.

SAE J2917, *Occupant Restraint and Equipment Mounting Integrity — Frontal Impact System-Level Ambulance Patient Compartment*, 2010.

2.3.7 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096, www.ul.com.

ANSI/UL 153, *Standard for Portable Electric Luminaires*, 2002, Revised 2010.

ANSI/UL 498, *Standard for Safety Attachment Plugs and Receptacles*, 2001, Revised 2010.

ANSI/UL 969, *Standard for Marking and Labeling Systems*, 1995, Revised 2008.

ANSI/UL 1598, *Luminaires*, 2008, Revised 2010.

ANSI/UL 2034, *Standard for Safety, Single and Multiple Station Carbon Monoxide Alarms*, 2008, Revised 2009.

2.3.8 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402, www.gpo.gov.

Title 49, Code of Federal Regulations, Part 571, Subpart B, "Federal Motor Vehicle Safety Standards" (FMVSS), No. 108, "Lamps, reflective devices, and associated equipment – passenger cars, multipurpose passenger vehicles, trucks, busses, trailers, (except pole trailers and trailer converter dollies), and motorcycles."

Title 49, Code of Federal Regulations, Part 571, Subpart B, "Federal Motor Vehicle Safety Standards" (FMVSS), No. 202, "Head restraints for passenger vehicles."

Title 49, Code of Federal Regulations, Part 571, Subpart B, "Federal Motor Vehicle Safety Standards" (FMVSS), No. 206, "Door locks and door retention components – passenger cars, multipurpose passenger vehicles, and trucks."

Title 49, Code of Federal Regulations, Part 571, Subpart B, "Federal Motor Vehicle Safety Standards" (FMVSS), No. 210, "Seat belt assembly anchorages."

Title 49, Code of Federal Regulations, Part 571, Subpart B, "Federal Motor Vehicle Safety Standards," (FMVSS), No. 213, "Child restraint systems – passenger cars, multipurpose passenger vehicles, trucks, and busses, and child restraint systems for use in motor vehicles and aircraft."

Title 49, Code of Federal Regulations, Part 571, Subpart B, "Federal Motor Vehicle Safety Standards" (FMVSS), No. 302, "Flammability of interior materials – passenger cars, multipurpose passenger vehicles, trucks, and busses."

2.3.9 Other Publications.

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

2.4 References for Extracts in Mandatory Sections.

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

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

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

Chapter 3 Definitions

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

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

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

3.2.3 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 are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the *Manual of Style for NFPA Technical Committee Documents*.

3.3 General Definitions.

3.3.1 Acceptance. An agreement between the purchasing authority and the contractor that the terms and conditions of the contract have been met. [**1901,** 2009]

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 out of hospital medical care and patient transport, which 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 gross vehicle weight rating (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.

3.3.3.4 *Type II Ambulance.* An ambulance constructed on a van.

3.3.3.5 *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.

3.3.3.6 *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.

3.3.4 Angle.

3.3.4.1 *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.

3.3.4.2 *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.

3.3.4.3 *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. [**1901,** 2009]

3.3.5 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.

3.3.6 Bonded (Bonding). Connected to establish electrical continuity and conductivity. [**1901,** 2009]

3.3.7 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 functions other than control.

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. [**1901,** 2009]

3.3.11.2 ***Line Voltage Conductor.*** An ungrounded current-carrying conductor of a line voltage circuit. [**1901,** 2009]

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. [**1901,** 2009]

3.3.12 Continuous Duty. Operation at a substantially constant load for an indefinitely long time. [**1901,** 2009]

3.3.13* Contractor. The person or company responsible for fulfilling an agreed upon contract. [**1901,** 2009]

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. [**1901,** 2009]

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. [**1901,** 2009]

3.3.18 Exterior. A nonsheltered location exposed to the environment, either continuously or intermittently. [**1901,** 2009]

3.3.19 Federal Motor Vehicle Safety Standards (FMVSS). Regulations promulgated by the National Highway Traffic Safety Administration (NHTSA) of the United States under Public Law 89-563 that 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. [**1901,** 2009]

3.3.23 Gauge. A visual device that indicates a measurement. [**1901,** 2009]

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. [**1901,** 2009]

3.3.26* Grade. A measurement of the angle used in road design and expressed as a percentage of elevation change over distance. [**1901,** 2009]

3.3.27 Ground Clearance. The clearance under a vehicle at all locations except the axles and driveshaft connections to the axle or items designed to swing clear. [**1901,** 2009]

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. [**1901,** 2009]

3.3.32 Interlock. A device or arrangement by means of which the functioning of one part is controlled by the functioning of another. [**1901,** 2009]

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. [**1901,** 2009]

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. [**1901,** 2009]

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. [**1901,** 2009]

3.3.41 Optical Power. A unit of measure designated as candela-seconds/minute that combines the flash energy and flash rate of an optical source into one power measurement representing the true visual effectiveness of the emitted light. [**1901,** 2009]

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

3.3.43 Optical Warning Device. A manufactured assembly of one or more optical sources. [**1901,** 2009]

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. [**1901,** 2009]

3.3.46 Power Source. A device that produces line voltage electricity. [**1901,** 2009]

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. [**1901,** 2009]

3.3.48 Proper(ly). In accordance with the manufacturer's specifications or as recommended by the manufacturer. [**1901,** 2009]

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. [**1901,** 2009]

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]

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

3.3.55 Reserve Capacity. The ability of a battery to sustain a minimum electrical load in the event of a charging system failure or a prolonged charging system deficit. [**1901,** 2009]

3.3.56 Seat.

3.3.56.1 ***Child Restraint Seat.*** A seat capable of transporting a child 66 lb (30 kg) or less in accordance with FMVSS 213 and mounted in accordance with the seat manufacturer's recommendation.

3.3.56.2 ***Infant Restraint Seat.*** A seat capable of transporting an infant 22 lb (10 kg) or less in accordance with FMVSS 213 and mounted in accordance with the seat manufacturer's recommendation.

3.3.57 Side Entry Door. The body door on the side of the ambulance body that provides entry into the patient compartment and through which patients can be loaded and unloaded.

3.3.58 Sign. A visual indication whether in pictorial or word format that provides a warning to the operator or other persons near the ambulance.

3.3.59 Stretcher. A non-elevating transportation device designed to transport a supine patient, which is also known as a litter or flat.

3.3.60 Striker. A mechanical device with which the latch engages on the opposing member of the body framework.

3.3.61 Switch. Any set of contacts that interrupts or controls current flow through an electrical circuit. [**1901,** 2009]

3.3.62 Total Continuous Electrical Load. The total current required to operate all of the devices permanently connected to the ambulance that can be simultaneously energized excluding intermittent-type loads.

3.3.63 Turning Clearance Radius. One-half the larger of the left or right full circle wall-to-wall turning diameter. [**1901,** 2009]

3.3.64 Usable Payload. The weight of the loose equipment, occupants, and cot that can be carried in the ambulance without exceeding the GVWR.

3.3.65 Weight.

3.3.65.1* ***Curb Weight.*** The total weight of the complete ambulance less the payload.

3.3.66 Weight Rating.

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

3.3.66.2 ***Gross Combination Weight Rating (GCWR).*** The final stage manufacturer's specified maximum loaded weight for a combination (articulated) vehicle consisting of a tow vehicle and one or more towed units.

3.3.66.3* ***Gross Vehicle Weight Rating (GVWR).*** The final stage manufacturer's specified maximum load-carrying capacity of a single vehicle.

3.3.67 Wet Location. A location on a nonenclosed, exterior surface of an ambulance body or driving and crew compartment or a nonsheltered location inside a compartment with a door or cover that, while open, exposes the enclosure or panelboard to the environment.

Chapter 4 General Requirements

4.1 General. All ambulances shall comply with Chapters 1 through 9.

4.2 Responsibility of the Purchaser.

4.2.1 It shall be the responsibility of the purchaser to consider the amount of equipment and personnel that will be carried on the ambulance and to specify a minimum usable payload that will accommodate this weight once the ambulance is placed in service.

4.2.2 It shall be the responsibility of the purchaser to specify any details of the ambulance that would exceed the minimum specifications of this standard.

4.2.3 After acceptance of the ambulance, the purchaser shall be responsible for ongoing training of personnel to develop and maintain proficiency regarding the proper and safe use of the ambulance and the associated equipment.

4.3 Responsibility of the Contractor.

4.3.1 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.

4.3.1.1 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.

4.3.1.2 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.

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

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

4.4 Ambulance Components.

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

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

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

4.4.4 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.

4.5 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. [**1901:** 4.7.4]

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. [**1901:** 4.7.6]

4.6.6 Programs shall be in place for training, proficiency testing, and performance verification of any staff involved with certification. [**1901:** 4.7.7]

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
(7) Applicable specification references and test requirement
(8) Summary of the test report
(9) A certifying statement with official signature

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 ambulance product 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. [**1901:** 4.8]

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. [**1901:** 4.8.1]

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. [**1901:** 4.8.3]

4.7.4 Appropriate forms or data sheets shall be provided and used during the testing. [**1901:** 4.8.4]

4.7.5 Programs shall be in place for training, proficiency testing, and performance verification of any personnel involved with certification. [**1901:** 4.8.5]

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. [**1901:** 4.8.6]

4.7.7 Certification documentation shall be delivered with the ambulance, including results of the certification tests. [**1901:** 4.8.7]

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. [**1901:** 4.9.1]

4.8.2 Electrical insulation or isolation shall be provided where necessary in order to prevent electrical shock from onboard electrical systems. [**1901:** 4.9.2]

4.8.3 Vehicular workmanship shall ensure an operating environment free of accessible sharp projections and edges. [**1901:** 4.9.3]

4.8.4 Safety-related (caution, warning, danger) signs shall meet the requirements of ANSI Z535.4, *Product Safety Signs and Labels*. [**1901:** 4.9.4]

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 4.9.2.1 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's or the patient's ingress into or egress from 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.

4.11.3.1.2 The ambulance and all systems, components, and equipment shall be capable of being stored at an ambient temperature between 32°F and 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 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, provided 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 deliver that load distribution plan 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)
(2) Certification of compliance of the optical warning system *(see 7.9.16)*
(3) Siren manufacturer's certification of the siren *(see 7.10.1.1)*
(4) Written load analysis and results of the electrical system performance tests *(see Section 9.5 and Section 9.9)*
(5) Certification of slip resistance of all exterior stepping, standing, and walking surfaces *(see Section 6.11)*

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
(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.

Ambulance Data

Manufactured By _____ Mo./Yr. _____
Address _____
City _____ State _____ Zip _____
VIN _____ Job No. _____
Chassis Model _____ Statement of Exception Applies _____
Vehicle Type _____ Usable Payload (lb or kg)* _____

This ambulance is certified by the manufacturer to conform to the edition of NFPA 1917, *Standard for Automotive Ambulances,* in effect on the date the ambulance is 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 that can be carried in this ambulance without exceeding the GVWR.

FIGURE 4.16.3.1 Certification and Payload Label.

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

4.16.3.3 The calculation of the usable payload listed on the label shall also be provided with the ambulance.

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.

5.1.3 Label.

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).

Table 5.1.1 Required GVWR Calculation

Component		Weight (lb)
Chassis		
Ambulance body complete		
Automotive fluids		
Permanently mounted equipment		
Loose equipment (Use one of these values unless the required loose equipment is specified by the purchaser)	Type I Type I-AD	750 1250
	Type II Type III Type III-AD	500 750 1250
Belted occupant seating positions	(No. Seats) ×	171
Cot patient		171
Cot	Standard cot Power cot	100 150
Spare capacity		200
Minimum GVWR required		

Note: 1 lb = 0.45 kg.

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).

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

5.3.3 An engine hour meter 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.

5.4.1* An engine speed auxiliary control device (high-idle switch, throttle, or automatic voltage monitor) shall be installed to allow an increase in the engine speed when the ambulance is parked.

5.4.2 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.

5.5 Cooling System.

5.5.1* The engine's cooling system shall maintain a temperature at or below the engine manufacturer's maximum coolant temperature.

5.5.2 Compliance of the engine's cooling system shall be validated by testing a substantially similar ambulance in accordance with Section 9.14.

5.6 Exhaust System.

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

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

5.6.3 The tailpipe outlet shall not terminate within 12 in. (300 mm) of the vertical axis of the fuel fill opening, oxygen storage, or patient entry doors where these features are located on the same side of the vehicle.

5.7 Braking System.

5.7.1 All brakes shall be readily accessible for inspection.

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

(1) An automatic moisture ejector
(2) An air dryer
(3) A pressure protection valve to prevent all air-operated accessories from drawing air from the air brake system when the air system's pressure drops below a pressure setting no lower than 80 psi (550 kPa)

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

5.8 Suspension.

5.8.1* With the exception of the OEM's furnished and installed components, the ambulance shall provide not less than the following clearance, measured in accordance with SAE J689, *Approach, Departure, and Ramp Break over Angles*:

(1) Approach angle of 10 degrees
(2) Ramp breakover of 10 degrees
(3) Departure angle of 10 degrees

5.8.2* A traction control feature shall be provided.

5.8.3 Shock absorbers shall be furnished on the front and rear axles.

5.8.4 Any ambulance with an air-ride suspension shall include an air dryer and automatic heated moisture ejection device to ensure that the air system is provided with dry air to protect the suspension control components.

5.9 Wheels and Tires.

5.9.1 Hub caps or wheel covers shall be removable without loosening the lug nuts so that wheels can be readily observed for daily inspection.

5.9.2 Mud Flaps.

5.9.2.1 Mud flaps, at least as wide as the tire(s), shall be provided behind the front and rear wheels and shall be reinforced at the point of attachment to the vehicle.

5.9.2.2 Mud flaps shall be permitted to be incorporated into the running boards.

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

5.9.4 Bodies designed with wheel openings shall have the rear wheels centered, within ±2 in. (±52 mm) of those openings.

5.9.5* Each tire shall be equipped with a visual indicator or monitoring system that indicates tire pressure.

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 The rear bumper of Type I and Type III vehicles 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(s) 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 mm^2) 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 the 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.

5.14.4 Each side view mirror's reflective surface outboard edge shall extend at least 1 in. (25.4 mm) beyond the outside of the modular body.

5.15 Cab Integrity. Cabs on ambulances with a GVWR greater than 26,000 lb (11,800 kg) shall meet the requirements of SAE J2420, *COE Frontal Strength Evaluation — Dynamic Loading Heavy Trucks*, and SAE J2422, *Cab Roof Strength Evaluation — Quasi-Static Loading Heavy Trucks*.

Chapter 6 Patient Compartment

6.1 Patient Compartment Configuration. The patient compartment shall provide a minimum of 275 ft^3 (7.7 m^3) of space, less volume for cabinets, while complying with 6.1.1 and 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 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 Section 9.1.

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 (e.g., 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, or 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.

6.5.2.1 The body shall be sealed and vented so that the interior carbon monoxide level does not exceed 13 ppm of carbon monoxide (CO).

6.5.2.2 The patient compartment shall include a listed CO detector in accordance with ANSI/UL 2034, *Standard for Safety, Single and Multiple Station Carbon Monoxide Alarms.*

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 housing openings shall allow for tire chain usage and easy tire removal and service and conform to SAE J683, *Tire Chain Clearance — Trucks, Buses (Except Suburban, Intercity, and Transit Buses), and Combinations of Vehicles.*

6.6.3 The 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 cab and the patient compartment.

6.7.2 The partition(s) shall be located directly behind the driver's seat and the cab passenger seat 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 cab and body bulkheads shall have an aligned window opening of at least 150 in.^{2} (96,780 mm^2) or other means of visual and hands-free audio communication.

6.7.6 If so equipped, a window in the cab or body shall be of 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 (e.g., cross-hatched stainless steel, rubberized), noncorrosive material.

6.8.3 Exterior access handrails shall be between 1 in. and 1⅝ 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 of 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 OEMs 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 mm^2) 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.

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 the 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. × 24 in. (610 mm × 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.

6.11.4 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.

6.12.6 Any absorbent material, such as carpeting, fabric, or inside/outside plastic-type carpeting, that resists cleaning and decontamination shall not be used.

6.13 Floor.

6.13.1 The patient compartment floor shall be flat, except where 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.

Table 6.9.11 Loads Withstood on Ambulance Door Latches and Hinges

	Side Door				Rear Door			
	Transverse Load		Longitudinal Load		Transverse Load		Longitudinal Load	
Latch or Hinge	lbf	N	lbf	N	lbf	N	lbf	N
Fully latched position	2,500	11,120	2,500	11,120	2,500	11,120	2,500	11,120
Secondary latched position	1,500	6,672	1,500	6,672	1,500	6,672	1,500	6,672
Hinge	2,500	11,120	2,500	11,120	2,500	11,120	2,500	11,120

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 midpoint 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, *Standard Test Method for Performance of Wood and Wood-Based Floor and Roof Sheathing Under Concentrated Static and Impact Loads.*

6.13.7.2.2.1 If panel joints occur at the maximum span location, 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 that have opening panel(s) inside the patient compartment shall not be acceptable.

6.16.3 Where 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) or higher above the floor and shall not protrude more than 2 in. (51 mm) if located lower than 14 in. (356 mm) or higher 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 contaminants.

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 lb (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 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, *Occupant Restraint and Equipment Mounting Integrity — Frontal Impact System-Level Ambulance Patient Compartment.*

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 and referring to 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.

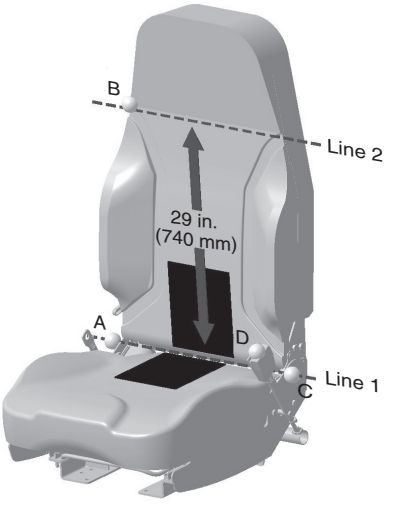


FIGURE 6.21.3.2.1 Dimension Lines for Measuring Seat Belt Effective Length.

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. Where 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 32 in. (813 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 If the primary patient care position is at the patient torso position, the fore-aft position of the seat shall be capable of lining up within 6 in. (152 mm) of the midpoint between the head end of the cot and the backrest hinge.

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 at 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 an 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.

6.21.10 Seatbelt Warning System.

6.21.10.1 An occupant restraint warning system shall be provided for each designated seating position in the patient compartment.

6.21.10.2 The warning system shall indicate if an occupant in the patient compartment is not belted or restrained.

6.21.10.3 The warning system shall consist of an audible and visual warning device that can be heard and seen by the driver and seen by the occupants of the patient compartment.

6.21.10.4 The warning shall be activated when the parking brake is released and the transmission is not in neutral or park.

6.21.10.5 The warning system shall not show an affirmative indication unless it has determined that the seat was occupied before the seat belt or restraint was buckled.

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 manufacturer's recommended retention force or a minimum retention force of 2200 lb (998 kg) applied in the longitudinal, lateral, and vertical directions.

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 that is 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 level 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 approached from the front
(2) 50 percent of the overall ambulance length visible when approached 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 (e.g., receptacles, cracks between slats in roll up doors), provided the full stripe is conspicuous as the ambulance is approached.

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 6.25.1.

6.25.5 Any vertically hinged door shall have at least 60 in.^{2} (38,710 mm^2) 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, *Standard Specification for Retroreflective Sheeting for Traffic Control*, Section 6.1.1, shall have a minimum coefficient

of retroreflection of 10 with an observation angle of 0.2 degrees and an 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, *Standard Specification for Retroreflective Sheeting for Traffic Control*, 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 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 26.4 gpm (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 (0 kPa to 17,237 kPa) graduated in not more than 100 psi (690 kPa) increments
(4) A locking adjustment preset at 50 psi ± 2 psi (345 kPa ± 14 kPa) line pressure

6.28.8.2 The regulator shall meet the performance 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 (345 kPa ± 14 kPa), a 26.4 gpm (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 mm^2) of open vent to dissipate or 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 holder shall 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 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 Each outlet shall be capable of delivering at least 26.4 gpm (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 following: "The integrity of this oxygen system was tested in accordance with NFPA 1917 and meets the requirements thereof."

6.28.11.3 The 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. (51 mm) Hg and a minimum total range of 0 in. to 30 in. (0 mm to 762 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 ¼ 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, "Acceptability of Electronic Assemblies," Classification 1.4.1 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 9.5.

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. [**1901:**13.2.1]

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

7.2.1.3 The use of star washers for circuit ground connections shall not be permitted. [**1901:**13.2.1.2]

7.2.1.4 All circuits shall otherwise be wired in conformance with SAE J1292, *Automobile, Truck, Truck-Tractor, Trailer, and Motor Coach Wiring.* [**1901:**13.2.1.3]

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 Electrical harnesses or wires that pass through the oxygen compartment 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. [**1901:**13.2.2.1]

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. [**1901:**13.2.2.1.1]

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. [**1901:**13.2.2.1.2]

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. [**1901:**13.2.2.1.3]

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. [**1901:**13.2.2.2]

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. [**1901:**13.2.3]

7.2.2.4 All wiring connections and terminations shall use a method that provides a positive mechanical and electrical connection. [**1901:**13.2.4]

7.2.2.4.1 The wiring connections and terminations shall be installed in accordance with the device manufacturer's instructions. [**1901:**13.2.4.1]

7.2.2.4.2 Wire nut, insulation displacement, and insulation piercing connections shall not be used. [**1901:**13.2.4.3]

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 Connections at exterior lights and fixtures shall utilize sealed connectors or sealed 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. [**1901:**13.2.5]

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 4.16.2.3(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. [**1901:**13.2.7]

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. [**1901:**13.2.7.1]

7.2.2.10.2 Circuit protection shall be accomplished by utilizing fuses, circuit breakers, fusible links, or solid state equivalent devices. [**1901:**13.2.7.2]

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*
[**1901:**13.2.7.3]

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, that 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 the 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. [**1901:**13.3.1]

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 9.5.3.4.

7.4 Operational Electrical Load Test Conditions.

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

(1) The propulsion engine and transmission
(2) All legally required clearance and marker lights, headlights, and other electrical devices except windshield wipers and four-way hazard flashers
(3) The radio(s) at a duty cycle of 10-percent transmit and 90-percent receive (for calculation and testing purposes, a default value of 5 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. [**1901:**13.3.4.1]

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 9.5.4.

7.4.4 A voltmeter shall be mounted on the driver's instrument panel to allow direct observation of the system voltage. [**1901:**13.3.5]

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. [**1901:**13.3.6.1]

7.5.2 The minimum continuous electrical loads specified in 7.4.1 shall not be subject to automatic load management. [**1901:**13.3.6.2]

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 ambulance 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 9.5.3.2.

7.6.2 The battery system cold cranking amps (CCA) rating shall meet or exceed the minimum CCA recommendations of the engine manufacturer. [**1901:**13.4.3]

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

7.6.3.1 The batteries shall be readily accessible for examination, testing, and maintenance. [**1901:**13.4.4.1]

7.6.3.2 Where an enclosed battery compartment is provided, it shall be ventilated to the exterior to prevent the buildup of heat and explosive fumes and separated from the occupant compartments.

7.6.3.3* The batteries shall be protected against vibration and temperatures that exceed the battery manufacturer's recommendation. [**1901:**13.4.4.4]

7.6.4 A means shall be provided for jump-starting the engine if the batteries are not accessible without lifting the cab of a tilt-cab ambulance. [**1901:**13.4.4.2]

7.6.5* An onboard battery conditioner or charger shall be provided for maintaining batteries in a fully charged condition.

7.6.6 Any associated line voltage electrical power system shall be installed in accordance with Chapter 8.

7.6.7* A master load disconnect shall be provided between the starter solenoid(s) and the patient compartment electrical loads.

7.6.8 Starter Solenoid.

7.6.8.1 The starter solenoids shall be connected directly to the chassis batteries.

7.6.8.2 Electronic control systems and similar devices shall be permitted to be otherwise connected if so specified by their manufacturer. [**1901:**13.4.6.2]

7.6.9 The alternator shall be wired directly to the batteries through the ammeter shunt(s), if one is provided, and not through the master load disconnect switch. [**1901:**13.4.6.3]

7.6.10 A sequential switching device shall be permitted to energize the optical warning devices required in Section 7.9 and other high current devices, provided the switching device shall first energize the electrical devices required in Section 7.9 within 5 seconds. [**1901:**13.4.7]

7.6.11 Two automotive power point type connectors shall be furnished in the patient compartment for charging all portable battery–powered devices (e.g., suction units, hand lights, defibrillators, and portable radios).

7.6.11.1 The power point circuits shall prevent discharge of chassis batteries by permitting the charging of portable devices only when the vehicle's ignition is on or the automatic charger/conditioner is connected to shore power.

7.6.11.2 The power point circuits shall be protected by a minimum 10 amp circuit breaker.

7.6.11.3 The power point circuits shall include a (low voltage drop) Schottky diode or other solid-state equivalent devices to isolate medical equipment batteries from any electrical loads that the remainder of the ambulance electrical system could impose.

7.6.11.3.1 If a Schottky diode is used, it shall be heat-sink mounted, have an inverse voltage rating of at least 45 volts, and also be rated to carry the maximum short-circuit current until the circuit breaker opens.

7.6.11.3.2 If a Schottky diode is used, it shall be physically located in an accessible location and be electrically connected between the circuit breaker and the power point connectors.

7.6.12 An additional tagged, identified lead shall be furnished in both the cab and the module for connection of additional (future) portable equipment that requires recharging.

7.7 Temperature Exposure. Any alternator, electrical starting device, ignition wiring, distributor, or ignition coil shall be moisture resistant and protected such that it is not exposed to a temperature that exceeds the component manufacturer's recommendations. [**1901:**13.6]

7.8* Electromagnetic Interference. Electromagnetic interference suppression shall be provided, as required, to satisfy the radiation limits specified in 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).* [**1901:**13.7]

7.9 Optical Warning Devices. Each ambulance shall have a system of optical warning devices that meets or exceeds the requirements of this section.

7.9.1* The optical warning system shall consist of an upper and a lower warning level. [**1901:**13.8.1]

7.9.2 The requirements for each level shall be met by the warning devices in that particular level without consideration of the warning devices in the other level. [**1901:**13.8.2]

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. [**1901:**13.8.3]

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.

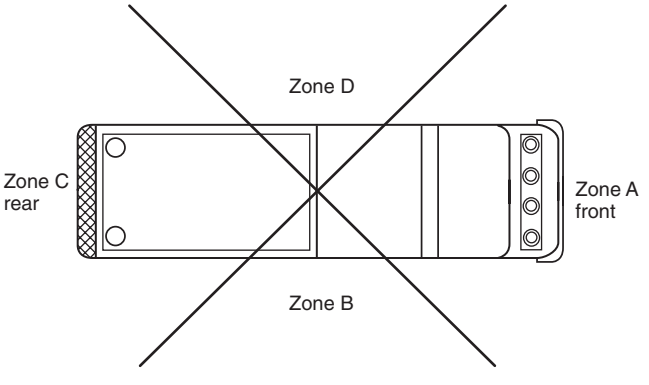


FIGURE 7.9.3.2 Warning Zones for Optical Warning Devices.

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. [**1901:**13.8.5]

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. [**1901:**13.8.6.3]

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. [**1901:**13.8.7]

7.9.7.1 When the master optical warning system switch is closed and the parking brake is released or the automatic transmission is not in park, the warning devices signaling the call for the right-of-way shall be energized. [**1901:**13.8.7.1]

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 blockage of the right-of-way shall be energized. [**1901:**13.8.7.2]

7.9.7.3* The system shall be permitted to have a method of modifying the two signaling modes. [**1901:**13.8.7.3]

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). [**1901:**13.8.8]

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. [**1901:**13.8.11.1]

7.9.11.1.1 Steadily burning, nonflashing optical sources shall be permitted to be used. [**1901:**13.8.11.1.1]

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. [**1901:**13.8.11.1.2]

7.9.11.2 The flasher of any current-interrupted flashing device shall otherwise meet the requirements of SAE J1690, *Flashers.* [**1901:**13.8.11.2]

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. [**1901:**13.8.12.1]

Table 7.9.12.1 Zone Colors

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

[**1901:** Table 13.8.12.1]

7.9.12.2 All colors shall be as specified in SAE J578, *Color Specification*, for red, blue, yellow, or white. [**1901:**13.8.12.2]

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. [**1901:**13.8.13.2.2]

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. [**1901:**13.8.13.3.3]

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. [**1901:**13.8.13.4.2]

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. [**1901:**13.8.13.4.3]

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. [**1901:**13.8.13.5]

Table 7.9.13.5 Minimum Optical Power Requirements for Large Ambulance

		Mode of Operation					
		Calling for Right-of-Way			Blocking Right-of-Way		
Zone	Level	*H* Total	At Any *H* Point	At Any Point 5 Degrees Up or 5 Degrees Down from *H*	*H* Total	At Any *H* Point	At Any Point 5 Degrees Up or 5 Degrees Down from *H*
A	Upper	1,000,000	10,000	3,500	400,000	10,000	3,500
B	Upper	400,000	10,000	3,500	400,000	10,000	3,500
C	Upper	400,000	10,000	3,500	800,000	10,000	3,500
D	Upper	400,000	10,000	3,500	400,000	10,000	3,500
A	Lower	150,000	3,750	1,300	150,000	3,750	1,300
B	Lower	150,000	3,750	1,300	150,000	3,750	1,300
C	Lower	150,000	3,750	1,300	150,000	3,750	1,300
D	Lower	150,000	3,750	1,300	150,000	3,750	1,300

Notes:
H = Horizontal plane passing through the optical center.
(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.
[**1901:** Table 13.8.13.5]

7.9.13.6 No individual measurement point shall be less than that shown in Table 7.9.13.5. [**1901:**13.8.13.6]

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 Upper-Level Optical Warning Devices.

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. [**1901:**13.8.14.2.1]

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. [**1901:**13.8.14.2.2]

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. [**1901:**13.8.14.3.2]

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. [**1901:**13.8.14.3.3]

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. [**1901:**13.8.14.4]

7.9.14.5 No individual measurement point shall be less than that shown in Table 7.9.14.4. [**1901:**13.8.14.5]

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.* [**1901:**13.8.15.1.1]

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. [**1901:**13.8.15.1.2]

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 7.9.15.2.5.2. [**1901:**13.8.15.2.1]

7.9.15.2.1.1 The results of the testing shall be used to determine compliance with this standard, and all required photometric data shall be available, upon request, from the optical warning device manufacturer. [**1901:**13.8.15.2.1.1]

Table 7.9.14.4 Minimum Optical Power Requirements for Small Ambulance

	Mode of Operation					
	Calling for Right-of-Way			Blocking Right-of-Way		
Zone	*H* Total	At Any *H* Point	At Any Point 5 Degrees Up or 5 Degrees Down from *H*	*H* Total	At Any *H* Point	At Any Point 5 Degrees Up or 5 Degrees Down from *H*
A	1,000,000	10,000	3,500	400,000	10,000	3,500
B	200,000	8,000	3,500	200,000	8,000	3,500
C	400,000	10,000	3,500	800,000	10,000	3,500
D	200,000	8,000	3,500	200,000	8,000	3,500

Notes:
H = Horizontal plane passing through the optical center.
(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.
[**1901:** Table 13.8.14.4]

7.9.15.2.1.2 The goniometer, integrating photometer, and other equipment used to take the test measurements shall meet the requirements of SAE J1330, *Photometry Laboratory Accuracy Guidelines*. [**1901:**13.8.15.2.1.2]

7.9.15.2.2 The optical source shall be mounted in a goniometer and operated as it would be in a normal system application. [**1901:**13.8.15.2.2]

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). [**1901:**13.8.15.2.2.1]

7.9.15.2.2.2 The goniometer shall be oriented and the integrating photometer shall be set to integrate light pulses from the source for 20 seconds. [**1901:**13.8.15.2.2.2]

7.9.15.2.3 For all tests performed with the power applied, the lighting system, or 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. [**1901:**13.8.15.2.3]

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. [**1901:**13.8.15.2.3.1]

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. [**1901:**13.8.15.2.3.2]

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. [**1901:**13.8.15.2.4]

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. [**1901:**13.8.15.2.5]

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. [**1901:**13.8.15.2.5.1]

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. [**1901:**13.8.15.2.5.2]

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 devices and performed by a qualified person demonstrates that the combination of individual devices as installed meets the requirements of this standard
(3) Actual measurement of the lighting system after installation on the 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.

7.9.17.1.1 The system shall display highly perceptible and attention-getting signals that function in a modal 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 12 fixed red lights, 1 fixed clear light, and 1 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 shall be able to 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.

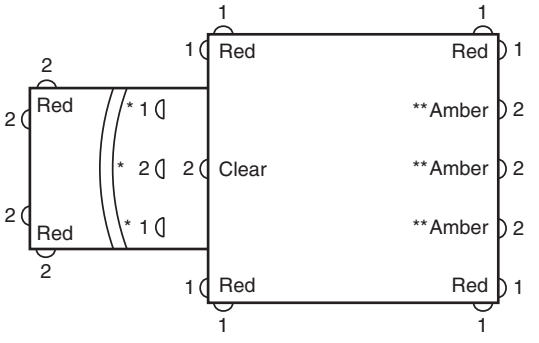
7.9.17.3 Photometric, Chromaticity, and Physical Requirements.

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, *Color Specification*, for their respective colors, except for the red lights, which can conform to the 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, measured in candelas per second (Cd-s), from the H-V to all the extreme test point coordinates and shall be tested at all 5-degree increments.



FLASH PATTERN

* 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

MINIMUM FLASH ENERGY, Cd-S PER FLASH, PER FIXTURE

Color	Red		Clear	Amber
Location	Grille and fenders	Upper body corners	Front center	Rear center*
Day	160 Cd-S @ HV	240 Cd-S @ HV	900 Cd-S @ HV	600 Cd-S @ HV
	80 Cd-S @ ± 5° H points	120 Cd-S @ ± 5° H points	450 Cd-S @ ± 5° H points	300 Cd-S @ ± 5° H points
	12 Cd-S @ all 5° V – 45° H points	32 Cd-S @ all 5° V – 45° H points	96 Cd-S @ all 5° V – 45° H points	72 Cd-S @ all 5° V – 45° H points
Night	10–30% of the above			

* Single center rear or combined dual rear (optional).

MODAL EMERGENCY LIGHTING SYSTEM

Color & Location / Mode of Operation	Red	Clear	Amber	Red
	Front and rear corners	Front upper center	Rear center	Grill and fender
Primary (Clear the right-of-way)	On	On	On	On
Secondary (Hazard: vehicle stopped on right-of-way)	On	Off	On	Off

FIGURE 7.9.17.2.1 Emergency Lighting.

7.9.17.3.4.1 At no point shall the Cd-s values drop to less than the minimum values as shown in Figure 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, *Optical Warning Devices for Authorized Emergency, Maintenance, and Service Vehicles*, 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.

7.9.17.5 The emergency lighting system shall be comprised of components and devices that comply with the general requirements and tests of SAE J575, *Test Methods and Equipment for Lighting Devices and Components for Use on Vehicles Less Than 2032 mm in Overall Width*, SAE J576, *Plastic Material or Materials for Use in Optical Parts Such as Lenses and Reflex Reflectors of Motor Vehicle Lighting Devices*, SAE J578, *Color Specification*, and 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)*, as applicable for the unit.

7.9.17.5.1 Warning lights shall be firmly fastened to reinforced body surfaces in accordance with the lighting manufacturer's requirements and recommendations and shall include aiming wedges to compensate for sloped body surfaces, grille, hood, and fender angles or mold release angles on roof caps.

7.9.17.5.2 The manufacturer shall aim the lights to ensure that all lighting performance requirements herein are met.

7.9.17.5.3 The lights shall be aimed either mechanically or optically on the horizontal axis with a tolerance of +0 degrees to –3 degrees.

7.9.17.5.4 All switches, connectors, and wiring shall be rated to carry a minimum of 125 percent of their maximum ampere load.

7.9.17.5.5 When halogen or another long-duty cycle light source is used, the duty cycle of any device shall not exceed 50 percent.

7.9.17.5.6 When strobe lights are furnished, all high voltage leads and connections shall be insulated and enclosed, or weatherproof connectors with the proper voltage rating shall be used.

7.9.17.6 Tests of Warning Light System.

7.9.17.6.1 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.

7.9.17.6.2 The warning light system and related components and devices shall be tested and approved by an Automotive Manufacturers Equipment Compliance Agency (AMECA) accredited laboratory independent from the lighting device manufacturer's own labs and listed with the AMECA for compliance with the requirements in *AMECA Compliance Handbook for GSA and SAE Warning Lamp Systems.*

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. [**1901:**13.9.1]

7.10.1.1 The siren manufacturer shall certify the siren as meeting the requirements of SAE J1849, *Emergency Vehicle Sirens.* [**1901:**13.9.1.1]

7.10.1.2* A means shall be provided to allow the activation of the siren within reach of the driver. [**1901:**13.9.1.2]

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.

7.11.2 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 shall control each side independently.

7.11.3 Load Lighting.

7.11.3.1 The loading area shall be illuminated to a level of at least 1 footcandle (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.

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

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

7.11.3.4 Load lights shall turn on whenever the rear patient entry doors are opened.

7.11.3.5 Load light switches shall allow for manual operation when the doors are closed.

7.11.4 Ambulance Exterior DOT Lighting.

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

7.11.4.2 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 ambulance shall have sufficient lighting to provide an average level of 1 fc at each seating surface in the driving compartments.

7.11.6.2 Driving compartment lighting shall be designed and located so that no glare is reflected into the driver's eyes or his line of vision from switch control panels or other areas that are illuminated while the vehicle is in motion.

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 1½ in. (38 mm) from the mounting surface.

7.11.6.3.4 The patient compartment lighting shall have the two levels of lighting, high and low, at a minumum.

7.11.6.3.4.1 In the high setting, the patient compartment floor shall have a minimum of 15 fc of illumination, measured along the centerline of the clear floor.

7.11.6.3.4.2* In the high setting, the primary cot shall be provided with a minimum of 35 fc of illumination, measured on at least 90 percent of the cot's surface area.

7.11.6.3.4.3 In the low setting, the patient compartment floor shall have a minimum of 3.5 fc of illumination, measured along at least 85 percent of the centerline length.

7.11.6.3.4.4 In the low setting, the side entry step shall have a minimum of 2.0 fc of illumination, measured in the center of the step area.

7.11.6.3.4.5 Compliance of the requirements in 7.11.6.3.4.1 through 7.11.6.3.4.4 shall be validated by testing a substantially similar ambulance in accordance with Section 9.16.

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 ft^3 (0.1 m^3) in volume and having an opening greater than 144 $in.^2$ (92,900 mm^2) 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
(3) Dust
(4) Corrosion
(5) High temperature
(6) Low temperature
(7) Durability
(8) Warpage

7.12 Do-Not-Move Ambulance Light.

7.12.1* A red flashing or rotating light or electronic display within the forward view of the driver shall be illuminated automatically whenever the ambulance's ignition switch is in the run position, the parking brake is not fully engaged, and any of the following conditions exist:

(1) Any passenger, patient entry, or equipment compartment door is not closed.
(2) Any equipment rack is not in the stowed position.
(3) Any other device permanently attached to the ambulance is open, extended, or deployed in a manner that is likely to cause damage to the ambulance if the ambulance is moved.

7.12.2 Compartments meeting all of the following conditions shall be permitted to be exempt from the requirements of 7.12.1:

(1) The volume is less than or equal to 4 ft^3 (0.1 m^3).
(2) The compartment has an opening less than or equal to 144 $in.^2$ (92,900 mm^2).
(3) The open door does not extend sideways beyond the mirrors or up above the top of the ambulance.

7.12.3 If the ambulance is equipped with a do-not-move ambulance light, the light shall be labeled to read "Do Not Move Unit."

7.13* Backup Alarm.

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

7.13.2 The backup alarm shall not have capacity to be turned off or disconnected.

7.14 Stop, Tail, and Directional Lights.

7.14.1 The ambulance shall be equipped with all FMVSS 108 legally required stop, tail, and directional lights.

7.14.2 Directional lights shall be visible according to FMVSS 108.

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

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

7.15 Communications Equipment.

7.15.1 Any two-way radio equipment shall be installed in accordance with the requirements of the radio equipment manufacturer.

7.15.2* Sufficient ventilated space for a two-way radio, including convenience features, antenna openings, ground plane, terminal wiring for 12-volt power, and ground, shall be provided.

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. [**1901:**22.2.3.1]

8.2.1.1 Where the requirements of this chapter differ from those in *NFPA 70*, the requirements in this chapter shall apply.[**1901:**22.2.3.2]

8.2.1.2 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.

8.2.1.3 All equipment and materials shall be installed in accordance with the manufacturer's instructions. [**1901:**22.2.5]

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 amps and conforming to the National Electrical Manufacturers Association (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 Where 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, the 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.

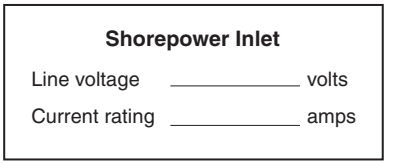


FIGURE 8.2.2.6 Shoreline Inlet Power Label.

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, the 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 Location Ratings.

8.2.5.1 Any equipment used in a dry location shall be listed for dry locations. [**1901:**22.6.1]

8.2.5.2 Any equipment used in a wet location shall be listed for wet locations. [**1901:**22.6.2]

8.2.5.3 Any equipment, except a PTO-driven generator, used in an underbody or underchassis location that is subject to road spray shall be either listed as Type 4 or mounted in an enclosure that is listed as Type 4. [**1901:**22.6.3]

8.2.5.4* If a PTO-driven generator is located in an underbody or underchassis location, the installation shall include a shield to prevent road spray from splashing directly on the generator. [**1901:**22.2.6.4]

8.2.6 Line Voltage Electrical System Testing. Electrical system testing shall be performed according to Section 9.9.

8.3 Grounding and Bonding.

8.3.1* Grounding.

8.3.1.1 Grounding shall be in accordance with 250.34(A) and 250.34(B) of *NFPA 70*. [**1901:**22.3.1]

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. [**1901:**22.3.1.1]

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. **[1901:**22.3.1.3]

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 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 an 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. [**1901:**22.3.2.1]

8.3.3.2 The neutral bonding connection shall occur only at the power source. [**1901:**22.3.2.2]

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. [**1901:**22.3.2.3]

8.3.3.3.1 The conductor shall have a minimum amperage rating, as defined in 310.15, "Ampacities for Conductors Rated 0–2000 Volts," of *NFPA 70*, of 115 percent of the rated amperage on the power source specification label. [**1901:**22.3.2.3.1]

8.3.3.3.2 A single conductor that is sized to meet the low voltage and line voltage requirements shall be permitted to be used. [**1901:**22.3.2.3.2]

8.3.3.3.3 All exposed non-current-carrying metal parts that could become energized shall be effectively bonded to the grounding terminal or enclosure of the distribution panelboard.

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

8.3.3.3.4.1 Aluminum or coppered aluminum conductors shall not be used.

8.3.3.3.4.2 Any ambulance that employs a unitized metal chassis–frame construction to which the distribution panel is securely fastened with a bolt and nut shall be considered to be bonded.

8.3.3.3.5 The ambulance body and exterior covering shall be considered bonded when the following criteria have 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.

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

8.3.3.3.7 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. [**1901:**22.4]

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. [**1901:**22.4.1]

8.5.2 The power source shall be shielded from contamination that would prevent the power source from operating within its design specifications. [**1901:**22.4.2]

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 the 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. [**1901:**22.4.3.2]

8.5.5 Access shall be provided to permit both routine maintenance and removal of the power source for major servicing. [**1901:**22.4.4]

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. [**1901:**22.4.6.1]

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. [**1901:**22.4.6.2]

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

[**1901:**22.4.6.3]

8.5.7.4 The instrumentation shall be permanently mounted at an operator's panel. [**1901:**22.4.6.4]

8.5.7.4.1 The instruments shall be located in a plane facing the operator. [**1901:**22.4.6.4.1]

8.5.7.4.2 Gauges, switches, or other instruments on this panel shall each have a label to indicate their function. [**1901:**22.4.6.4.2]

8.5.7.4.3 The instruments and other line voltage equipment and controls shall be protected from mechanical damage and not obstructed by tool mounting or equipment storage. [**1901:**22.4.6.4.3]

8.5.8 An instruction plate(s) that provides the operator with the essential power source operating instructions, including the power-up and power-down sequence, shall be permanently attached to the ambulance at any point where such operations can take place. [**1901:**22.4.7]

8.5.9 Operation.

8.5.9.1 Provisions shall be made for placing the generator drive system in operation using controls and switches that are identified and within reach of the operator while seated in the driver's seat or standing upright on the ground.

8.5.9.2 Where the generator is driven by the chassis engine and engine compression brakes or engine exhaust brakes are furnished, they shall be automatically disengaged for generator operations. [**1901:**22.4.8.2]

8.5.9.3* Any control device used in the generator system power train between the engine and the generator shall be equipped with a means to prevent unintentional movement of the control device from its set position in the power generation mode. [**1901:**22.4.8.3]

8.5.10 If there is permanent wiring on the ambulance that is designed to be connected to the power source, a power source specification label that is permanently attached to the ambulance at the operator's control station shall provide the operator with the information detailed in Figure 8.5.10.

Power Source Specifications

Operational Category	Continuous Duty Rating
Rated voltage(s) and type (ac or dc)	
Phase	
Rated frequency	
Rated amperage	
Continuous rated watts	
Power source engine speed	

FIGURE 8.5.10 Power Source Specification Label. [1901:Figure 22.4.9]

8.5.11 The power source, at any load, shall not produce a noise level that exceeds 90 dBA in any driving compartment, crew compartment, or onboard command area with windows and doors closed or at any operator's station on the ambulance.

8.6 Power Source–Type Specific Requirements.

8.6.1* Direct Drive (PTO) Generators. If the generator is driven by any type of PTO, it shall meet the requirements of 8.6.1.1 through 8.6.1.3.

8.6.1.1 The transmission's PTO port and PTO, or the split shaft PTO, and all associated driveshaft components shall be rated to support the continuous duty torque requirements of the generator's continuous duty rating as stated on the power source nameplate. [**1901:**22.5.1.1]

8.6.1.2 The direct drive generator shall be mounted so that it does not change the ramp breakover angle, angle of departure, or angle of approach as defined by other components, and it shall not extend into the ground clearance area. [**1901:**22.5.1.4]

8.6.1.3 The direct drive generator shall be mounted away from exhaust and muffler areas or provided with a heat shield to reduce operating temperatures in the generator area. [**1901:**22.5.1.5]

8.6.2* Hydraulically Driven Generators. If the generator is driven using hydraulic components, it shall meet the requirements of 8.6.2.1 through 8.6.2.3.4.

8.6.2.1* A means shall be provided to activate the hydraulic generator system. [**1901:**22.5.2.1]

8.6.2.2 If the hydraulic generator system is not capable of output as stated on the power source specification label at all engine speeds, an automatic engine speed control system shall be provided. [**1901:**22.5.2.2]

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. [**1901:**22.5.2.4.1]

8.6.2.3.2 Hydraulic hose shall meet the hydraulic pump manufacturer's recommendations for pressure, size, vacuum, and abrasion resistance. [**1901:**22.5.2.4.2]

8.6.2.3.3 Hydraulic fittings shall meet the hydraulic pump manufacturer's recommendations for pressure, size, and the type of hose used. [**1901:**22.5.2.4.3]

8.6.2.3.4 Where the hydraulic hose comes into contact with other surfaces, the hose shall be protected from chafing. [**1901:**22.5.2.5]

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. [**1901:**22.5.3.2]

8.6.3.3 The generator shall be installed in accordance with the generator manufacturer's requirements for ventilation and service accessibility. [**1901:**22.5.3.3]

8.6.3.4 If the generator is installed in a compartment and the compartment doors need to 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. [**1901:**22.5.3.4]

8.6.3.5 If the generator is installed in a compartment on a slide tray and the slide tray must 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. [**1901:**22.5.3.5]

8.6.3.6 Permanently installed generators shall have readily accessible engine oil drain provisions or piping to a remote location for oil changing. [**1901:**22.5.3.6]

8.6.3.7 If the generator is located in a position on the ambulance where the operator cannot see the instrumentation and operate the controls while standing at ground level or positioned at a specifically designated operator station, an operating panel with the required instrumentation, start and stop controls, and other controls necessary for safe operation shall be provided at a remote operator's panel.

8.6.3.7.1 A visual and audible warning shall be provided in the ambulance cab, visible from the operator's seat to do the following:

(1) Visually indicate that the generator engine is operating
(2) Visually and audibly indicate that the generator engine is in operation when the ambulance ignition is off

8.6.3.7.2 The audible warning shall be permitted to be equipped with an override function that resets automatically when the ignition is cycled on.

8.6.3.7.3 The generator engine shall shut down and be prevented from restarting automatically when connection to an external source of electrical power ("shore power") is established.

8.6.3.8 Fuel System.

8.6.3.8.1 Fuel lines shall be protected from chafing at all wear points. [**1901:**22.5.3.8.1]

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. [**1901:**22.5.3.9.2]

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. [**1901:**22.5.3.9.3]

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. [**1901:**22.5.3.9.4]

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. [**1901:**22.5.5.2]

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. [**1901:**22.5.6.1]

8.6.5.2 An interlock shall prevent engagement of the generator unless the parking brake is engaged and the transmission is in neutral or not connected to the drive wheels. [**1901:**22.5.6.2]

8.6.5.3* Where the chassis engine drives the generator and electronic engine throttle controls are provided, an interlock shall prevent engine speed control from any other source that would interfere with the generator while the generator is operating. [**1901:**22.5.6.3]

8.6.6* Waveform Created Electronically. If the power output waveform is electronically created (as with invertors and some generators), the purchaser shall specify whether modified sine wave or pure sine wave output is required.

8.7* Portable Generator Installations. The generator shall comply with Article 445, "Generators," of *NFPA 70*. [**1901:**22.6]

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. [**1901:**22.6.2]

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. [**1901:**22.6.3.1]

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. [**1901:**22.6.3.2]

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. [**1901:**22.6.3.3]

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 where so recommended by the power source manufacturer. [**1901:**22.6.3.4]

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. [**1901:**22.6.3.5]

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. [**1901:**22.7.2.1]

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 power source are connected. [**1901:**22.7.2.2]

8.8.3 The neutral conductor shall be switched through the transfer switch. [**1901:**22.7.2.3]

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. [**1901:**22.8.1]

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. [**1901:**22.8.2]

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). [**1901:**22.8.3]

8.10 Overcurrent Protection. Manually resettable overcurrent devices shall be installed to protect the line voltage electrical system components. [**1901:**22.9]

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. [**1901:**22.9.1]

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. [**1901:**22.9.1.1]

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. [**1901:**22.9.1.2]

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*. [**1901:**22.9.2]

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. [**1901:**22.9.2.1]

8.10.2.2 Each overcurrent protection device shall be marked with a label to identify the function of the circuit it protects. [**1901:**22.9.2.2]

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. [**1901:**22.9.2.3]

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.

[**1901:**22.9.3]

8.10.3.1 The panel shall be visible and located so that there is unimpeded access to the panelboard controls. [**1901:**22.9.3.1]

8.10.3.2 All panelboards shall be designed for use in their intended location. [**1901:**22.9.3.2]

8.10.3.3 The panel(s) shall be protected from mechanical damage, tool mounting, and equipment storage. [**1901:**22.9.3.3]

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)

[**1901:**22.10]

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 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. **[1901:**22.10.2]

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. [**1901:**22.10.3]

8.11.3.1 Supports shall be made of nonmetallic materials or of corrosion-resistant or corrosion-protected metal. [**1901:**22.10.3.1]

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. [**1901:**22.10.4]

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, one inside and one outside 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. [**1901:**22.10.5]

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. [**1901:**22.10.6.1]

8.11.6.2 Where flexible cord penetrates a metal surface, rubber or plastic grommets or bushings shall be installed. [**1901:**22.10.6.2]

8.11.7 Wiring Identification.

8.11.7.1 Each line voltage circuit originating from the main panelboard shall be identified. [**1901:**22.10.7.1]

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. [**1901:**22.10.7.2]

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 and intended function. [**1901:**22.10.7.3]

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. [**1901:**22.11.1]

8.12.1.1 Conductors in flexible cord shall be sized in accordance with Table 400.5(A) of *NFPA 70*. [**1901:**22.11.1.1]

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*. [**1901:**22.11.1.2]

8.12.1.3 Aluminum or copper-clad aluminum conductors shall not be used. [**1901:**22.11.1.3]

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*. [**1901:**22.11.2]

8.12.2.1 All boxes shall be accessible using ordinary hand tools. [**1901:**22.11.2.1]

8.12.2.2 Boxes shall not be permitted behind welded or popriveted panels. [**1901:**22.11.2.2]

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*. [**1901:**22.11.2.3]

8.12.3* All wiring connections and terminations shall provide a positive mechanical and electrical connection. [**1901:**22.11.3]

8.12.3.1 Connectors shall be installed in accordance with the manufacturer's instructions. [**1901:**22.11.3.1]

8.12.3.2 Wire nuts or insulation displacement and insulation-piercing connectors shall not be used. [**1901:**22.11.3.2]

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. [**1901:**22.11.4]

8.12.4.1 All switches shall be marked with a label indicating the function of the switch. [**1901:**22.11.4.1]

8.12.4.2* Circuit breakers used as switches shall be "switch rated" (SWD) or better. [**1901:**22.11.4.2]

8.12.4.3 Switches shall simultaneously open all associated line voltage conductors. [**1901:**22.11.4.3]

8.12.4.4 Switching of the neutral conductor alone shall not be permitted. [**1901:**22.11.4.4]

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. [**1901:**22.11.4.5]

8.12.5* Receptacles and Inlet Devices.

8.12.5.1 The patient compartment shall be furnished with a minimum of three 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*. [**1901:**22.11.5.1.1]

8.12.5.6.2 All receptacles located in a wet location shall be not less than 24 in. (600 mm) from the ground. [**1901:**22.11.5.1.2]

8.12.5.6.3* Receptacles on off-road [ambulances] shall be a minimum of 30 in. (760 mm) from the ground. [**1901:** A.22.11.5.1.3]

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. [**1901:**22.11.5.2]

8.12.5.8 No receptacle shall be installed in a face-up position. [**1901:**22.11.5.3]

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. [**1901:**22.11.5.4]

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. [**1901:**22.11.5.5.1]

8.12.5.10.2 If the receptacle is dc or other than single phase, that information shall also be marked on the label. [**1901:**22.11.5.5.2]

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. [**1901:**22.11.5.6]

8.12.5.12 Receptacles used for dc voltages shall be rated for dc service. [**1901:**22.11.5.7]

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. [**1901:**22.12]

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. [**1901:**22.12.1]

8.13.3 Rollers or guides shall be provided, where required, to prevent damage to the cord at reel spools or compartment openings. [**1901:**22.12.2]

8.13.4 Rewind Provision.

8.13.4.1 Manually operated reels shall have a hand crank. [**1901:**22.12.3.1]

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. [**1901:**22.12.3.3]

8.13.4.5 The rewind control shall be marked with a label indicating its function and shall be guarded to prevent accidental operation. [**1901:**22.12.3.4]

8.13.5* The reel shall be designed to hold 110 percent of the capacity needed for the intended cord length. [**1901:**22.12.4]

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. [**1901:**22.12.5]

8.13.7* Electrical cord shall be Type SEOOW, Type SOOW, or Type STOOW. [**1901:**22.12.6]

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

[**1901:**22.12.7]

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. [**1901:**22.12.8]

8.13.9.1 The remote power distribution box shall be listed for use in a wet location. [**1901:**22.12.8.1]

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

[**1901:**22.12.8.2]

8.13.9.3 Inlets, receptacles, circuit breakers, or GFCI devices shall not be mounted on the top surface of the horizontal plane. [**1901:**22.12.8.3]

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. [**1901:**22.12.8.4]

8.13.9.5* Remote power distribution boxes shall have a light on the box to indicate the power is on. [**1901:**22.12.8.5]

8.13.9.5.1* The light shall be visible in a 360-degree plane from a minimum of 200 ft (60 m) in complete darkness. [**1901:**22.12.8.5.1]

8.13.9.5.2 The light shall be mechanically protected to prevent damage. [**1901:**22.12.8.5.2]

8.13.9.6 The hardwired portable cord connection to the box shall have strain relief and meet the intended usage requirements. [**1901:**22.12.8.6]

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. [**1901:**22.13.1]

8.14.3 Handle on Lights.

8.14.3.1 If the light is adjustable, a handle shall be provided. [**1901:**22.13.2.1]

8.14.3.2 The design of the light shall not allow the temperature of the handle to exceed 131°F (55°C). [**1901:**22.13.2.2]

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*. [**1901:**22.13.3]

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.

9.1.1.1 The following steps shall be performed during the 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.

9.1.1.2 The application plate required in 9.1.1.1(4) shall be a minimum of 5 in. (127 mm) longer and 5 in. (127 mm) wider than the vehicle roof of the patient's compartment.

9.1.1.3 For the purposes of the measurements in 9.1.1.2, the ambulance roof shall be that structure, seen in the top projected view, that coincides with the patient compartment of the ambulance, as shown in Figure 9.1.1.3(a) and Figure 9.1.1.3(b).

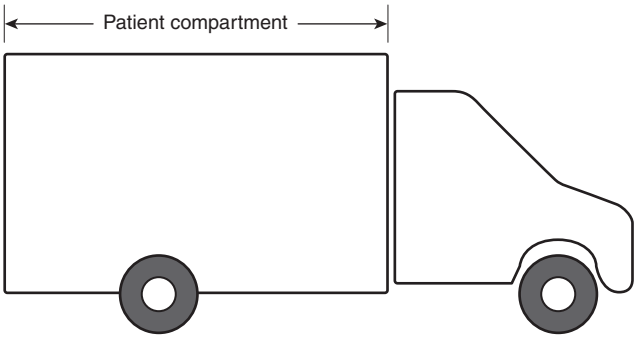


FIGURE 9.1.1.3(a) Type I and Type III Ambulance Patient Compartment Roof Measurement.

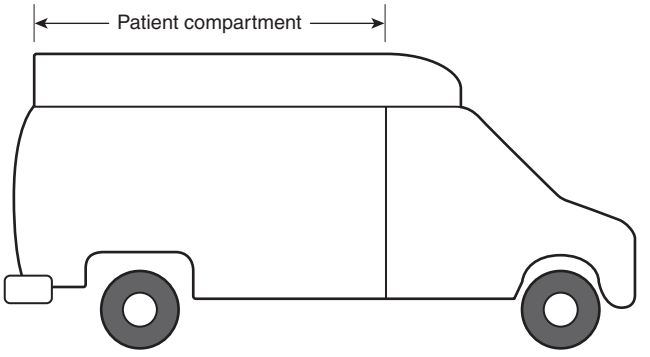


FIGURE 9.1.1.3(b) Type II Ambulance Patient Compartment Roof Measurement.

9.1.2 Side Crush Test (Type I and Type III Only).

9.1.2.1 The following steps shall be performed during the side crush test:

(1) Place either side of the body of the ambulance on a rigid horizontal surface so that the body of the ambulance is entirely supported.
(2) Measure and record the distance from the mounting surface to each of the four top corners of the body side.
(3) Employ a rigid, rectangular force application plate fitted as near as possible to the contour of the ambulance side.
(4) Position the force application plate so that it is centered on the patient compartment side.
(5) Close all ambulance doors.
(6) Load the application plate to 500 lb (227 kg) at a deflection rate less than 0.5 in. (13 mm) per second.
(7) Record elevation readings of all four corners of the body side.
(8) Load the application plate to 50 percent of the final load at a deflection rate less than 0.5 in. (13 mm) per second.
(9) Record elevation readings of all four corners of the body side.
(10) Load the application plate to 100 percent of the final load at a deflection rate less than 0.5 in. (13 mm) per second.
(11) Record elevation readings of all four corners of the body side.
(12) Verify that the rear patient compartment doors are capable of being opened and closed.
(13) Remove load.
(14) Verify that the rear patient compartment doors are capable of being opened and closed.

9.1.2.2 The application plate required in 9.1.2.1(3) shall be a minimum of 5 in. (127 mm) longer and 5 in. (127 mm) wider than the vehicle side of the patient's compartment.

9.2 Body Door Test (Type I and Type III Only).

9.2.1 The following steps 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 force for 10 seconds in all required directions and/or positions after the installation of associated body door retention components.
(4) Apply force for 10 seconds to a continuous hinge so that the load will be distributed equally from top to bottom.
(5) Apply force for 10 seconds to individual (strap-type) hinges so that the load will be distributed proportionally on each hinge.
(6) Apply force 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 steps shall be performed during the oxygen tank retention system static test as shown in Figure 9.3.1:

(1) Test the retention system in a substantially similar ambulance or mounted to a structure that is substantially similar to the ambulance.
(2) Apply forces using a rigid simulated cylinder having the same physical dimensions as the oxygen tank for which the tank holder was designed as shown in Figure 9.3.1
(3) Apply each force so that it passes through the location that corresponds to the center of gravity of a full tank.
(4) Apply the test force for 10 seconds in the direction of cylinder extraction and in both axial directions.

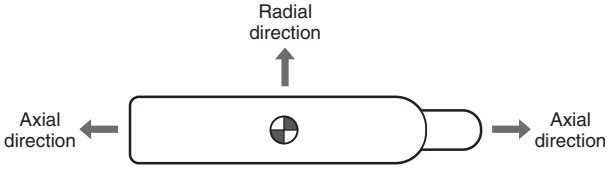


FIGURE 9.3.1 Oxygen Tank Retention Test.

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's 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 steps shall be performed during the patient compartment sound level test:

(1) Measure sound level using a meter that meets the requirements of ANSI S1.4, *Specification for Sound Level Meters*, for Type II meters with the meter set to A for a weighting 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 the 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 steps 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(a).
(2) Apply the force perpendicular to the mounting surface.
(3) Apply the force parallel to the mounting surface.
(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(b).
(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 the 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.

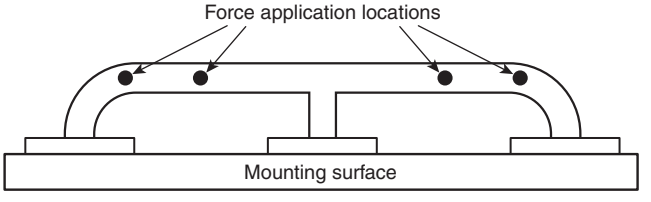


FIGURE 9.8(a) Location of Force Application on Handrail.

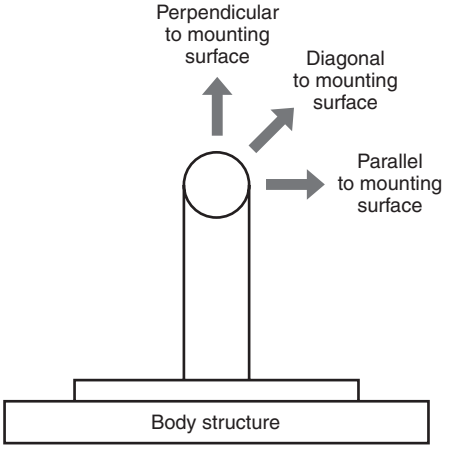


FIGURE 9.8(b) Direction of Force Application on Handrail.

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. The water leak 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)

9.10.1 The following steps shall be performed during the water leak 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 an additional 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 steps 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) Turn 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 steps 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 three thermocouples 7 in. (178 mm) off the floor along the patient compartment centerline and equally spaced from front to back.
(3) Locate three thermocouples 7 in. (178 mm) below the ceiling along the patient compartment centerline and equally spaced from front to back.
(4) Locate three thermocouples midway between the floor and the ceiling along the patient compartment centerline and equally spaced from front to back.
(5) Locate three 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 the first and third thermocouples along the centerline of the 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 the 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 the 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 the hood; all doors, with the exception of partition doors (if present); and all windows, with the exception of the patient compartment/cab partition window (if present).
(23) Set the air conditioners in the cab and the patient compartment to maximum cooling setting (maximum blower speed, coldest temperature setting, recirculating air).
(24) Record the thermocouple temperatures.
(25) Shut off the patient compartment dome lights.
(26) Start the engine and maintain the 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 steps 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).
(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, cab door windows, 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 steps 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 the system pressure with an accuracy of ±0.1 psi (0.7 kPa).
(5) Allow the system to rest without disturbance for 2 hours.
(6) Record the system pressure.

9.15.2 Flow Test. The following steps 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 ±0.07 ft^3/min (±2 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 steps 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, 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 $in.^2$ (322 mm^2) area on the test grid.

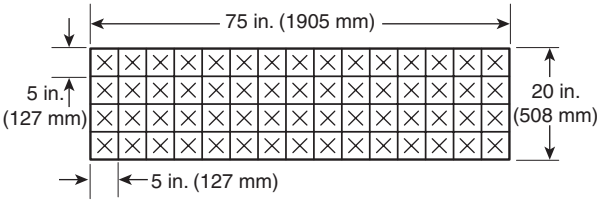


FIGURE 9.16 Patient Cot Test Grid, Top View.

9.17 Reserved.

9.18 Rear Stepping Surface Load Test. The following steps 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 a 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 steps 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.

9.21.1 Vacuum Test. The following steps 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 (0.666 kPa) to measure the vacuum in the collection bottle.
(3) Open the vacuum control valve and the shutoff valve to their full open position.
(4) Turn on the vacuum pump.
(5) Clamp or plug the end of the suction tubing.
(6) Measure and record the vacuum 4 seconds after plugging the tubing.

9.21.2 Flow Test. The following steps shall be performed during the flow test:

(1) Install a flow-measuring instrument capable of an accuracy of ±0.035 ft^3/min (1 L/min) to measure the flow in the suction tubing.
(2) Open the vacuum control valve and the 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 steps shall be performed during the perimeter illumination test:

(1) Place the ambulance in a dark environment.
(2) Ensure that the vehicle batteries are fully charged.
(3) Record the light intensity with a meter capable of measuring to an accuracy of ±0.01 fc.
(4) Construct a grid of test points off the sides and rear of the test ambulance, as shown in Figure 9.24.
   (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 midpoint 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 steps 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.

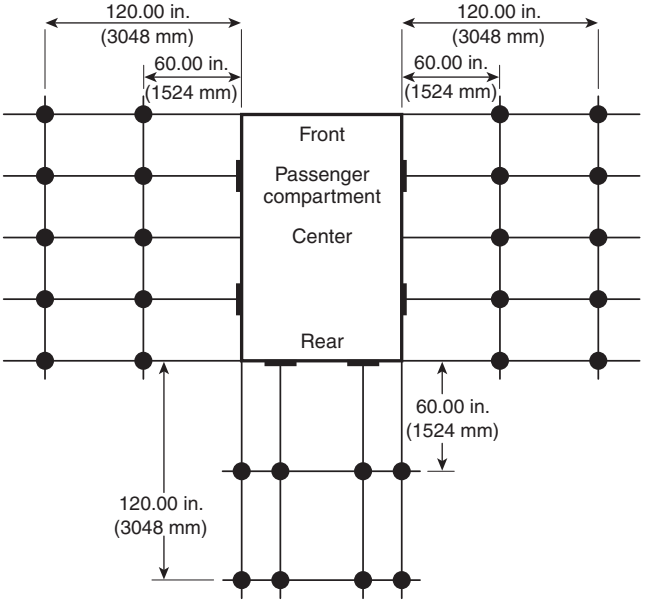


FIGURE 9.24 Perimeter Illumination Test Grid.

Annex A Explanatory Material

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

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

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.

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

Table A.1.6(a) Conversion Factors: U.S. Customary Units to SI Units

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

Table A.1.6(b) Conversion Factors: SI Units to U.S. Customary Units

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

Table A.1.6(c) Other Useful Conversion Factors

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

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

Table A.1.6(d) Abbreviations Used in This Standard

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

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.3.3.3.1 Substantially Similar Ambulance. It is not practical to test every production vehicle to validate performance compliance. The term *substantially similar* allows those requirements that call for a test on a substantially similar ambulance to be performed once rather than on every production vehicle.

A.3.3.9 Chassis. Common usage might, but need not, include a cab (or cowl).

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 wail, 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 can include, but is not limited to, medicines, first-aid supplies, oxygen tanks, child seats, and personal dunnage.

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 should be included in the test report if 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.4.9.2.2 Use of the "Star of Life" symbol must be in accordance with the purpose and use criteria set forth in published guidelines by the National Highway Traffic Safety Administration, an operating administration of the U.S. Department of Transportation.

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 This section describes a range of operating measures of the vehicle, and there may be different performance criteria specified for different tests. This section is not intended to prescribe test requirements for all ambulance characteristics. Refer to Chapter 9 for individual ambulance performance test requirements.

A.4.11.2 The purchaser should determine the types of grades on which the ambulance will be expected to operate when it is stationary. The occasional exposure to grades in excess of that required by this standard while an ambulance is moving over

roadways is different from prolonged stationary operations. 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 an ambulance or ambulance systems based on 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 in which the ambulance will operate and specify temperatures outside 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 could 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 for payload determination, btract 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:

$$\frac{(\text{Heavier weight} - \text{Lighter weight})}{\text{Total weight}} \times 100 = \text{Percent difference}$$

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.

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.

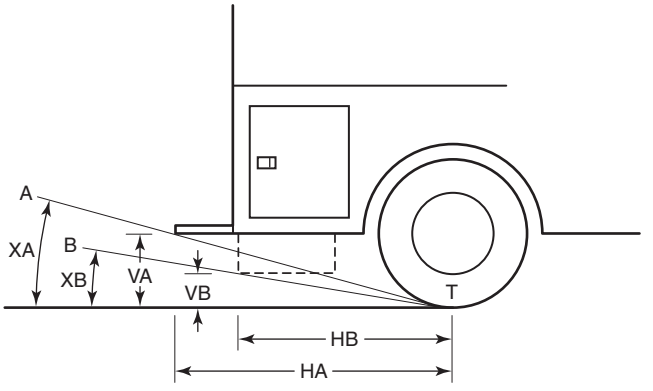


FIGURE A.5.8.1 Determination of Angle of Approach.

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.
(3) Hang a plumb bob from the lowest point and mark the point on the ground where the point of the plumb bob touches.
(4) Measure the vertical distance from the ground to the point where the plumb bob was hung (distance *V*).
(5) Measure the horizontal distance from the plumb bob point to the front of the steel strip or to the string running from rear tire to rear tire (distance *H*).
(6) Divide the vertical distance (*V*) by the horizontal distance (*H*).

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 it is available as an option or consider purchasing an ambulance configuration that offers ESC.

A.5.11.1 The purchaser might want to specify front and/or rear tow hooks or tow eyes 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 might not be perpendicular to the leading edge (common on chassis where it would be natural to not open the door completely to the 90-degree point and to enter the door opening at a diagonal from the rear). In such cases, the clearance measurement can be taken diagonally across the step in the natural direction of climb.

A.5.14 Purchasers might want to consider specifying that all mirror head faces be independently adjustable from the driver's position if this feature is available from the OEM.

A.6.7.5 Unless otherwise specified by the purchaser to delete walkthrough or to specify or approve alternative door opening dimensions, the door opening should be at least 17 in. (43 cm) wide and 46 in. (117 cm) high and should provide an aisle between the compartments. The door should have at least a 150 in.^{2} (968 cm^2) transparent, shatterproof viewing panel in the center section at the driver's eye level. The door should be secured by a cab-side self-latching device in both the open and the closed positions.

A.6.9.7 The requirement of 6.9.7 does not apply to both rear doors, only the primary door.

A.6.14.2 The purchaser may wish to consider the rear maximum load height based on the primary stretcher being utilized. Current accepted maximum load heights as stated by the cot manufacturers are 34 in. to 36 in. (863.6 mm) to 914.4 mm). The load height is dependent on the chassis chosen. Chassis with four-wheel drive are traditionally 4 in. to 6 in. (101.6 mm to 152.4 mm) higher than a comparable 4 × 2.

A.6.16 The following measuring guidelines are for cabinets and compartments:

(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 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 as Depth ID.
(2) Measure the cabinet interior from wall to wall and record that dimension as Width ID.
(3) Measure the interior from top to bottom and record that dimension as Height ID.
(4) Multiply Height ID × Width ID × Depth ID.
(5) If measurements are in inches, divide by 1728 for cubic feet.

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 the dimension as Door OD.

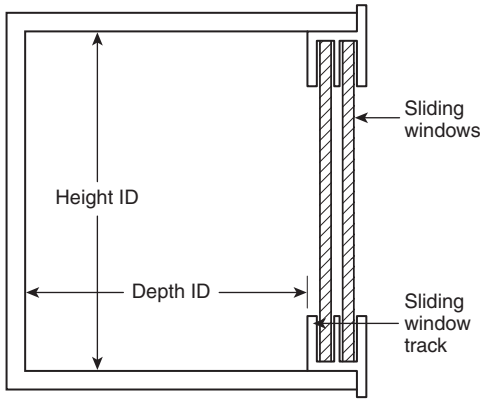


FIGURE A.6.16(a) Measurements of Interior Cabinets with Sliding Doors or Roll-up Doors.

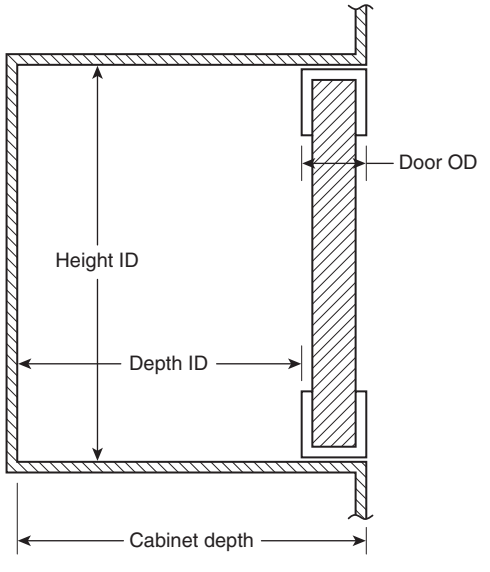


FIGURE A.6.16(b) Measurements of Interior Cabinets with Hinged Doors.

(2) Measure from the back of the rear wall to the cabinet face and record that dimension as the cabinet depth.
(3) Subtract Door OD from the cabinet depth for Depth ID.
(4) Measure the cabinet interior from wall to wall and record that dimension as Width ID.
(5) Measure the interior from top to bottom and record that dimension as Height ID.
(6) Multiply Height ID × Width ID × Depth ID.
(7) If measurements are in inches, divide by 1728 for cubic feet.

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 that dimension as Door OD.
(2) Measure from the back of the rear wall to the cabinet face and record that dimension as cabinet depth.
(3) Subtract Door OD from the cabinet depth for Depth ID.
(4) Measure the cabinet interior from wall to wall and record that dimension as Width ID.
(5) Measure the interior from top to bottom and record that dimension as Height ID.
(6) Multiply Height ID × Width ID × Depth ID.
(7) If measurements are in inches, 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.

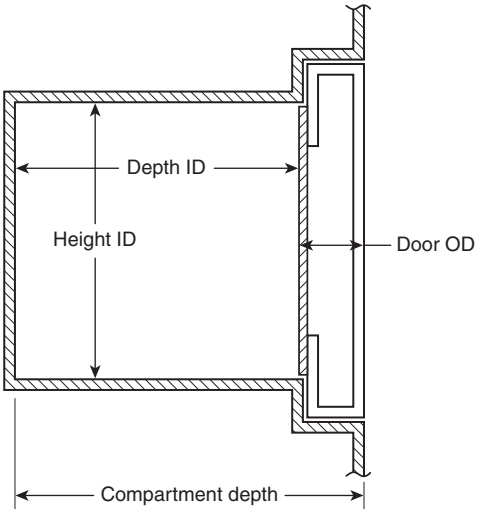


FIGURE A.6.16(c) Measurements for Exterior Compartments with Hinged Doors.

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, the seat backs must meet the requirements 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. That mission fails if the ambulance does not arrive safely. It is essential that the ambulance be 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 might 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. Methods of monitoring compliance with all safety precautions by personnel in the vehicle include 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 through ambulance windows for enforcement of seat belt use compliance.

Seat belt design is critical to safety during a crash. Seat belts should conform to FMVSS 210, S4.3.1.1, which requires that the lap portion of the belt in any designated seating position not constrain the occupant high across the belly.

A.6.23 Some chassis used on ambulances might not be capable of providing independent control of the HVAC units between the cab and the patient compartment. Purchasers might want to consider chassis selection if this feature would be important in the climate where the ambulance will be used.

A.6.25 Retroreflective contour stripes of any color affixed to the front, rear, and side surfaces of the ambulance to outline the vehicle profile can provide additional conspicuity. The purchaser might want to consider including such stripes 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 when necessary, and provide early warning of electrical failure in time to permit corrective action.

A.7.2.1.1 The requirement of 125 percent 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 requirement. Wiring supplied by the electrical device manufacturer 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 only low voltage wiring 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 the 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 amps," which determines 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 amperage 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 only be plugged 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 can 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, 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, *Performance Levels and Methods of Measurement of Electromagnetic Compatibility of Vehicles, Boats (up to 15 m), and Machines (16.6 Hz to 18 GHz)*, provides test procedures and recommended levels to assist engineers in the control of broadband electromagnetic radiation and in the control of radio interference resulting 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, while the lower-level optical warning devices provide warning in close proximity to the ambulance. *(See Figure A.7.9.1.)*

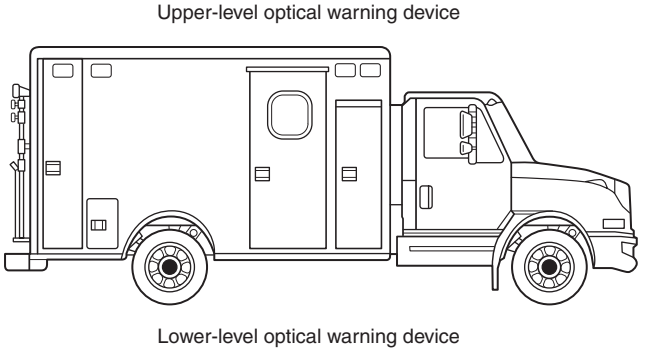


FIGURE A.7.9.1 Upper- and Lower-Level Optical Warning Devices.

A.7.9.7.3 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-level warning devices 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 the lower level. Although a single optical source can be used to provide warning signals into more than one zone, the possibility of a 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 at 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 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 ambulances 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.

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 center, *H,* throughout the 90 degrees included in the zone (19 data points). 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 at a given point is taken from the test report, and they are added together to determine the total optical power at that 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.

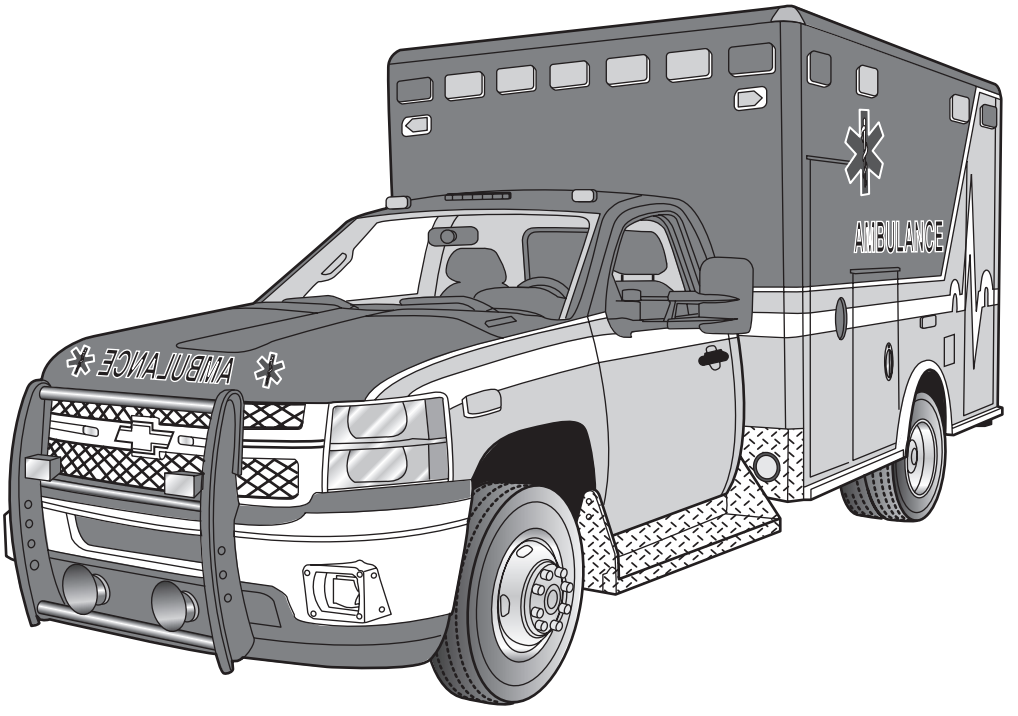


FIGURE A.7.9.13(a) Front and Left Side of Ambulance with Optical Warning System.

FIGURE A.7.9.13(b) Rear and Right Side of Ambulance with Optical Warning System.

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 the zone totals are then 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 want to type-certify by 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 mounted either 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. Photometric testing 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 optical 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.

A.7.10.1.2 If the purchaser wants to have the siren controls within convenient reach of persons riding in both the right and left front seat positions, that should be specified. In some ambulances, 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. 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.7.11.6.3.4.2 The purchaser should be aware that, even if technically considered "white" through industry standard color tolerances, care should be taken to ensure that interior lighting fixtures, primarily patient dome lights, maintain a uniform color hue (measured by color temperature in kelvins), across all like-installed light fixtures.

Experience indicates a color temperature nearest "daylight" (6500K) might be preferred, although that is commonly achievable only with LED or fluorescent light sources. Lower-cost incandescent and halogen patient dome lights typically fall within the "warmer" range of 2500K to 3500K. Care should be taken when selecting lighting fixtures to avoid wide variances 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 want to add at the sides or rear of a vehicle camera(s) with monitoring screens in the cab 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 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 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 ambulance for the power inlet. Consideration should be given to placement of the power inlet so that it disconnects if the ambulance 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.8.2.6.4 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 conductor terminals of the receptacles are connected