PROPOSED DRAFT

OF

NFPA 1917
Standard for Automotive Ambulances
2013 Edition

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3/19/2009

The Technical Committee on Ambulances is seeking public input on this draft as well as the National Truck and Equipment Association (NTEA), Ambulance Manufacturer's Division (AMD) Standards that are referenced in the draft. The Ambulance Committee will review the public input when considering the options as follows: keep the external AMD references as used in the draft; maintain the AMD references but add the committee's amendments, or the technical committee develop testing criteria without using external reference within the NFPA 1917 Ambulance Standard.

The AMD Standards can be viewed/downloaded at the following web link:

http://www.ntea.com/assets/0/160/162/196/202/248/A67A074F-6110-4506-A2A4-487B8E331599.pdf

NFPA 1917
Standard for
Automotive Ambulances

Chapter 1 Administration

1.1* Scope.
1.1.1 This standard establishes the minimum requirements for new automotive emergency medical services (EMS) ground vehicles used for out-of-hospital medical care and patient transport.

1.1.2 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.

1.2 Purpose. The purpose of this document is to specify minimum requirements, performance parameters, and essential criteria for the design of ground ambulances.

1.3 Application.
1.3.1 This standard shall apply equally to vehicles intended for use in both emergency and non-emergency operations.
1.3.2 This standard shall not apply to the following:

1. Refurbished and re-mounted vehicles
2. Vehicles that are used for transport of more than two stretcher-bound patients at the same time
3. Mass casualty vehicles
4. Military field ambulances
5. Vehicles intended for use as fire apparatus as specified in NFPA 1901 or NFPA 1906

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

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

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

1.5.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.
1.6* Units and Formulas. In this standard, values for measurement in U.S. customary units are followed by equivalents in SI units. 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®, 2008 edition.

2.3 Other Publications.
2.3 AMD Publications.
Ambulance Manufacturers Division (AMD), National Truck Equipment Association, 37400 Hills Tech Drive, MI 48331-3414
AMD 001 Ambulance Body Structure Static Load Test, 2007
AMD 002 Body Door Retention Components Test, 2007
AMD 003 Oxygen Tank Retention System Static Test, 2007
AMD 004 Litter Retention System Static Test, 2007
AMD 006 Patient Compartment Sound Level Test, 2007
AMD 008 Patient Compartment Grab Rail Static Load Test, 2007
AMD 010 Water Spray Test, 2007
AMD 011 Equipment Temperature Test, 2007
AMD 012 Interior Climate Control Test, 2007
AMD 014 Engine Cooling System Test, 2007
AMD 015 Ambulance Main Oxygen System Test, 2007
AMD 016 Patient Compartment Lighting Level Test, 2007
AMD 018 Rear Step and Bumper Static Load Test, 2007
AMD 021 Aspirator System Test, Primary Patient, 2007
AMD 022 Cold Engine Start Test, 2007
AMD 024 Perimeter Illumination Test, 2007
AMD 025 Measuring Guidelines: Occupant Head Clearance Zones, 2007

2.3.x ANSI Publications.
American National Standards Institute, Inc., 25 West 43rd Street, 4th floor, New York, NY 10036.
ANSI S1.4, *Specification for Sound Level Meters, for Type II Meters, 2006*
ANSI Z535.4, *Product Safety Signs and Labels, 2007*

2.3.x ASTM Publications.
ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, www.ASTM.org.
ASTM E 661, *Standard Test Method for Performance of Wood and Wood-Based Floor and Roof Sheathing Under Concentrated Static and Impact Loads*, 2009.
ASTM D 4956, *Standard Specification for Retroreflective Sheeting for Traffic Control*, 2009.

2.3.x California Government Publications.
Office of Administrative Law, 300 Capitol Mall, Suite 1250, Sacramento, California 95814-4339
California Administrative Code, Title 13, Article 8

2.3.x IPC Publications.
International Printed Circuits & Electronics, 309 S, Bannockburn, IL 60015
IPC-A-610D *Acceptability of Electronic Assemblies*, 2005

2.3.x ISO Publications.
International Standards Organization, 1 rue de Varembé, Case Postale 56, CH-1211 Genéve 20, Switzerland, www.standardsinfo.net.
ISO/IEC 17020, *General criteria for the operation of various types of bodies performing inspection*, 1998.

ISO/IEC Guide 65, *General requirements for bodies operating product certification systems*, 1996.

2.3.x SAE Publications.
Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096, www.SAE.org.
SAE J156, *Fusible Links*, 2005.
SAE J541, *Voltage Drop for Starting Motor Circuits*, 1996.
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 J560, *Primary and Auxiliary Seven Conductor Electrical Connector for Truck-Trailer Jumper Cable*, 2004.
SAE J575, *Test Methods and Equipment for Lighting Devices and Components for Use on Vehicles Less Than 2032 mm in Overall Width*, 2007.
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 J833, *Human Physical Dimensions*, 1989.
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 J1349, *Engine Power Test Code, Spark Ignition and Diesel*, 2004
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 J2180, *A Tilt Table Procedure for Measuring the Static Rollover Threshold for Heavy Trucks*, 1998.
SAE J2394, *Seven-Conductor Cable for ABS Power — Truck and Bus*, 2007.
SAE J2420, *COE Frontal Strength Evaluation — Dynamic Loading Heavy Trucks*, 2003.
SAE J2422, *Cab Roof Strength Evaluation — Quasi-Static Loading Heavy Trucks*, 2003.

2.3.x UL Publications.
Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096, www.UL.com.
UL 969, *Standard for Marking and Labeling Systems*, 2006.

2.3.x U.S. Government Publications.
U.S. Government Printing Office, Washington, DC 20402, www.gpo.gov.
Title 21, Code of Federal Regulations, Part 820: Quality System Regulation.
Title 29, Code of Federal Regulations, Part 1910.7 Definition and Requirements for a Nationally Recognized Testing Laboratory.
Title 29, Code of Federal Regulations, Part 1910.169, "Air receivers." 29 CFR 1910.169.
Title 29, Code of Federal Regulations, Part 1910.1030: Blood borne Pathogens.
Title 40, Code of Federal Regulations, Part 86: Control of Air Pollution from New Motor Vehicles and New Motor Vehicle Engines.
Title 47, Code of Federal Regulations, Part 90: Public Safety Radio Services (FCC).
Title 49, Code of Federal Regulations, Part 178.37, "Specification 3AA and 3AAX, seamless steel cylinders." 49 CFR 178.37.

Title 49, Code of Federal Regulations, Part 393 Federal Motor Carrier Safety Regulations (FMCSR).
Title 49, Code of Federal Regulations, Part 567, "Certification." 49 CFR 567.
Title 49, Code of Federal Regulations, Part 571 Federal Motor Vehicle Safety Standards (FMVSS).

2.3.x GSA Publications.
U.S. General Services Administration, 1800 F Street, N.W., Washington, DC 20405.

Single copies of GSA publications generally are available at the General Services Administration Business Centers in cities throughout the United States. They also are available from the U.S. Government Printing Office.

KKK-A 1822F Federal Specification for Ambulances, 2007

RR-C-901C/GEN(1) — General Specification for Cylinders, Compressed Gas, High Pressure, Steel DOT 3Aa, and Aluminum Applications, 1981

2.3.x U.S. Federal Standards:
U.S. Government Printing Office, Washington, DC 20402.

Federal Standard No. 297 — Rustproofing of Commercial (Nontactical) Vehicles
National Highway Traffic Safety Administration**,** Document Number DOT HS 808 721, Rev. June 1995**.**

2.3.x Military Standards:
Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.
MIL-STD-461 Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment, 1999
MIL-STD-1223 Non-tactical Wheeled Vehicles, Painting, Identification Marking, and Data Plate Standards, 1991.

2.3.x American College of Emergency Physicians (ACEP):
ACEP, 1125 Executive Circle, Irving, TX 75038-2522
Guidelines for Ambulance Equipment, 2007

2.3.x National EMSC (Emergency Medical Services for Children) Resource Alliance:
Emergency Medical Services for Children (EMSC) National Resource Center, 111 Michigan Ave., N.W, Washington, D.C 20010

Performance Measures Checklist for Recommended Pediatric Equipment and Supplies for BLS and ALS Ambulances, 2010

2.3.x Automotive Manufacturers Equipment Compliance Agency (AMECA):
AMECA**,** 1025 Connecticut Avenue, NW Suite #1012, Washington, D.C. 20036
AMECA Compliance Handbook, 2010

2.3.x 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®, 2008 edition.
NFPA 1451, *Standard for Fire Service Vehicle Operations Training Program*, 2007 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 shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

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

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

3.3.3Ambulance. A vehicle used for emergency medical care that provides a driver's compartment; a patient compartment to accommodate an emergency medical services provider (EMSP) and one patient located on the primary cot so positioned that the primary patient can be given intensive life-support 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 of the same type and that employs the same chassis make and engine model.

3.3.3.2 Type I Ambulance (10,001 to 14,000 GVWR). An ambulance with a cab chassis furnished with a modular ambulance body.

3.3.3.3 Type I-AD (Additional Duty) Ambulance (14,001 GVWR or More). An ambulance with a Cab-Chassis with modular ambulance body, increased GVWR, storage, and payload.

3.3.3.4 Type II Ambulance (10,000 and Under GVWR). An ambulance with a long wheelbase Van, with Integral Cab-Body.

3.3.3.5 Type III Ambulance (10,001 to 14,000 GVWR). An ambulance with a Cutaway Van with integrated modular ambulance body.

3.3.3.6 Type III-AD (Additional Duty) Ambulance (14,001 GVWR or More). An ambulance with a Cutaway Van with integrated modular body, and increased GVWR, storage, and payload.

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.

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.

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

3.3.8 Center of Gravity. The point at which the entire weight of the ambulance is considered to be concentrated so that, if supported at this point, the ambulance would remain in equilibrium in any position.

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

3.3.10 Compartment.
3.3.10.1 Enclosed Compartment. An area designed to protect stored items from environmental damage (weather resistant) that is confined on six sides and equipped with an access opening(s) that can be closed and latched.
3.3.10.2 Patient Compartment. The portion of the ambulance aft of the cab.
3.3.10.2.1 Type I Patient Compartment. The modular body area added on behind the cab.
3.3.10.2.2 Type II Patient Compartment. The body area beginning immediately behind the forward bulkhead.
3.3.10.2.3 Type III Patient Compartment. The modular body area added on behind the cab.

3.3.11 Conductor.
3.3.11.1 Grounding Conductor. A non–current-carrying conductor used to connect equipment or the ground circuit of a wiring system to the power source grounding system.
3.3.11.2 Line Voltage Conductor. An ungrounded current-carrying conductor of a line voltage circuit.
3.3.11.3 Neutral Conductor. The conductor connected to the neutral point of a system that is intended to carry current under normal conditions.

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

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

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

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

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

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

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

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

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

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

3.3.22 Gallon. United States gallon.

3.3.23 Gauge. A visual device that indicates a measurement.

3.3.24* GAWR. See 3.3.63.1, Gross Axle Weight Rating.

3.3.25* GCWR. See 3.3.63.2, Gross Combination Weight Rating.

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

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

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

3.3.29* GVWR. See 3.3.63.3, Gross Vehicle Weight Rating.

3.3.30 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.

3.3.31 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.

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

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

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

3.3.35 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.

3.3.36 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 30 V rms (ac), 42.4 V peak (ac), or 60 V dc; or greater.

3.3.37 Load.

3.3.37.1 Live Load. Forces acting on the aerial device from personnel, portable equipment, water, and nozzle

reaction.
3.3.37.2 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 such as primers and booster reel rewind motors.

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

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

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

3.3.41 Optical Power. A unit of measure designated as 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.

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

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

3.3.44 Panelboard. A single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall, partition, or other support; and accessible only from the front. [**70,** 2008]

3.3.45 Patient Cot. The cot, gurney or litter upon which the primary patient is transported.

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

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

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

3.3.49 psi. Pounds per square inch.

3.3.50 PTO. Power takeoff.

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

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

3.3.53 Qualified Person. A person who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, has demonstrated the ability to deal with problems relating to a particular subject matter, work, or project. [**1451,** 2007]

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.

3.3.56 Seat.
3.3.56.1 Child Restraint Seat. A seat capable of transporting a child 66 lb 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 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 may be loaded/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 Striker. A mechanical device with which the latch engages on the opposing member of the body framework.

3.3.60 Switch. Any set of contacts that interrupts or controls current flow through an electrical circuit.

3.3.61* Turning Clearance Radius. One-half the larger of the left or right full circle wall-to-wall turning diameter.

3.3.62 Weight.
3.3.62.1 Curb Weight. The total weight of the complete ambulance less the payload. 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.
3.3.62.2 Estimated In-Service Weight. The amount that the ambulance manufacturer estimates the ambulance will weigh when it is placed in service with all fixed and portable equipment installed, all tanks full, and all personnel seating positions occupied.
3.3.62.3 In-Service Weight. The maximum actual vehicle weight under any conditions of mobile operation, sometimes referred to as gross vehicle weight.

3.3.63 Weight Rating.
3.3.63.1* 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.
3.3.63.2* 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.
3.3.63.3* Gross Vehicle Weight Rating (GVWR). The final stage manufacturer's specified maximum load-carrying capacity of a single vehicle.

3.3.64 Wet Location. A nonsheltered location inside a compartment with a door or cover that, while open, exposes the electrical enclosure or panelboard to the same environmental conditions as the exterior of the ambulance. A location on a nonenclosed, exterior surface of a ambulance body or driving and crew compartment where the enclosure or panel is exposed to the environment.

Chapter 4 General Requirements

4.1 General.
All ambulances shall comply with the following chapters:
(1) Chapter 1, "Administration"
(2) Chapter 2, "Referenced Publications"
(3) Chapter 3, "Definitions"
(4) Chapter 4, "General Requirements"
(5) Chapter 5, "Chassis"
(6) Chapter 6, "Body"
(7) Chapter 7, "Low Voltage Electrical Systems and Warning Devices"
(8) Chapter 8, "Line Voltage Electrical Systems"
(9) Chapter 9, "Testing"

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 applicable manufacturer's installation instructions.

4.4.2 The emergency medical care vehicles; including chassis, ambulance body, equipment, devices, medical accessories, and electronic equipment shall be standard commercial products, tested and certified to meet or exceed the requirements of this standard.

4.4.3 All medical devices furnished shall comply with Food and Drug Administration (FDA) regulatory requirements.

4.4.4 Vehicles shall be free from defects that may impair their serviceability or detract from appearance.

4.4.5 All bodies, systems, equipment, and interfaces with the chassis shall be done in accordance with the OEM Body Builders Book.

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

(1) Applicable Federal Motor Vehicle Safety Standards (FMVSS)

(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 All testing unique to this standard other than those outlined in AMD Standards 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.*

4.6.2 The certification organization shall not be owned or controlled by manufacturers or vendors of the product that is being tested.

4.6.3 The certification organization shall be primarily engaged in certification work and shall not have a monetary interest in the product's ultimate profitability.

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

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

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

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

4.6.8 Appeal Process.

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

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

4.6.9 Accredited Laboratory.

4.6.9.1 All testing specified by AMD Standards shall be witnessed or performed by an organization that is accredited for inspection of ambulances in accordance with an ISO/IEC 17025 accredited laboratory that is

recognized by a signatory to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA).

4.6.9.2 The scope of accreditation shall include all tests outlined by Chapter 9 of this document.

4.6.10 Certification letters submitted for the ambulance model, components, and equipment being certified shall contain the following information on contractor's letterhead stationery in electronic format (pdf files):

(1) To whom certifying
(2) Date
(3) Units or items
(4) Contractor 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

4.6.11 The testing facility for each certification shall supply the following supportive verification data and information on letterhead stationery in electronic format (pdf files):

(1) For whom 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) Test conclusion(s)
(14) Witness(es)
(15) Authorized signature

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

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

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

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

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

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

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

4.7.7 Certification documentation shall be delivered with the ambulance, including results of the certification tests. Certification tests performed on a Substantially Similar Ambulance shall be valid for up to 7 years or until such time as the production product changes are so significant that they no longer meet the definition of a Substantially Similar Ambulance.

4.8 Personnel Protection.

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

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

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

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

4.9 Controls and Instructions.

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

4.9.2* All required signs, instruction plates, and labels shall be permanent in nature and securely attached and shall meet the requirements of 4.9.4 and UL 969, *Standard for Marking and Labeling Systems*.

4.9.2.1 The signs, instruction plates, and labels shall be resistant to 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) Ultra violet 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 EMSP while the ambulance is in motion shall be visible and within reach of the designated Primary Patient Care Position.

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

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

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

4.10 Vehicle Data Recorder.

4.10.1 All ambulances shall be equipped with an on-board vehicle data recorder (VDR).

4.10.2 The VDR shall be capable of recording the data shown in Table 4.10.2 in that order at least once per second.

Table 4.10.2 VDR Data

Data	Unit of Measure
Vehicle speed	mph
Acceleration (from speedometer)	mph/sec
Deceleration (from speedometer)	mph/sec
Engine speed	rpm
Engine throttle position	% of full throttle
Anti-lock braking system event	On/off
Seat occupied status	Occupied: Yes/No by position
Seat belt status	Buckled: Yes/No by position
Master optical warning device switch	On/off
Time	24-hour clock
Date	Year/month/day

4.10.3 Data shall be stored at the sampling rate in a 48-hour loop.

4.10.4 Memory shall be sufficient to record 100 engine hours' worth of minute-by-minute summary showing the data in Table 4.10.4.

Table 4.10.4 VDR Summary Data

Data	Unit of Measure
Maximum vehicle speed	mph
Maximum acceleration (from speedometer)	mph/sec
Maximum deceleration (from speedometer)	mph/sec
Maximum engine speed	rpm
Maximum engine throttle position	% of full throttle
Anti-lock braking system event	On/off
Seat occupied with seat belt unbuckled	Yes/no by position at 30 sec into minute
Master optical warning device switch	On/off at 30 sec into minute
Time	24-hour clock

4.10.5 When the memory capacity is reached, the system shall erase the oldest data first.
4.10.6 All data stored in the VDR shall be uploadable by the user to a computer and importable into a data management software package.
4.10.7 Data shall be password protected with access controlled by the purchaser.
4.10.8 Software shall be delivered with the ambulance that will run on both Windows® and Apple® operating systems and produce the following formatted reports from the uploaded data:

(1) Raw second-by-second data over a specified data/time range
(2) Daily log for the time the engine is running for a given date (minute-by-minute output of all values)
(3) Weekly summary (maximum values each hour for each day of the week)
(4) Monthly summary (maximum values each day for each day of the month)

4.11 Component Protection.
4.11.1* Hydraulic hose lines, air system tubing, control cords, and electrical harnesses shall be mechanically attached to the frame or body structure of the ambulance.
4.11.2 The types of equipment described in 4.11.1 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.
4.11.3 A through-the-frame connector shall be permitted to be used in place of protective looms or grommets.

4.12 Ambulance Performance.
4.12.1 The ambulance shall meet the requirements of this standard at elevations of 2,000 ft (600 m) above sea level.
4.12.2 The ambulance shall meet all the requirements of this standard while stationary on a grade of 6 percent in any direction.
4.12.3* Where temperature requirements are not otherwise specified, the ambulance shall be designed to function in ambient temperature conditions between -20°F (-29°C) and 110°F (43°C).
4.12.4 The ambulance shall be capable of being driven for at least 250 mi (402 km) without refueling.
4.12.5 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)
4.13 Roadability.
4.13.1 The ambulance, when loaded to its estimated in-service weight, shall be capable of the following performance while on dry, paved roads that are in good condition.
4.13.2 The determination shall be made by actual test or OEM's certified computer predition.

(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.

4.13.3 The maximum top speed of the ambulance shall not exceed either 72 mph (116 km/hr) or the manufacturer's maximum service speed rating for the tires installed on the ambulance, whichever is lower.
4.13.4* 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.
4.14 Serviceability.
4.14.1 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.

4.14.2 Where special tools are required for routine service on any component of the ambulance, such tools shall be provided with the ambulance.
4.14.3 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.
4.14.4 These components shall not be welded or otherwise permanently secured into place.

4.15 Tests on Delivery.

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

4.15.4 Certification from OEM and individual equipment manufacturers are acceptable providing they are not part of a system(s) or altered.

4.16* Documentation.

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

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

4.17 Data Required of the Contractor.

4.17.1 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 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) Engine make, model, serial number, rated horsepower.
   (h) Type of fuel and fuel tank capacity
   (i) Electrical system voltage and alternator output in amps
   (j) Battery make, model, and capacity in cold cranking amps (CCA)
   (k) Chassis transmission make, model, and serial number
   (l) Ratios of all driving axles
   (m) Maximum governed road speed
   (n) Paint manufacturer and paint number(s)
   (o) Company name and signature of responsible company representative
   (p) 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 9.1 and Section 9.2)*
(5) Certification of slip resistance of all exterior stepping, standing, and walking surfaces *(see 6.12)*

4.17.2 Operations and Service Documentation.

4.17.2.1 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.

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

4.17.2.3* 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) Pictorial representations of circuit logic for all electrical components and wiring
   (b) Circuit identification
   (c) Connector pin identification
   (d) Zone location of electrical components

(e) Safety interlocks
(f) Alternator–battery power distribution circuits
(g) Input/output assignment sheets or equivalent circuit logic implemented in multiplexing systems

(7) Lubrication charts
(8) Operating instructions for the chassis, 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) A material safety data sheet (MSDS) for any fluid that is specified for use on the ambulance.

4.17.3 Certification and Payload Signage.
4.17.3.1* All ambulances shall have a certification and payload label as shown in Figure 4.17.3.1.
4.17.3.2 The label shall be mounted on the body (module) interior in a conspicuous location.

4.17.3.3 All text in Figure 4.17.3.1 shall be included on the certification and payload label.

[Have drawn as art]

CERTIFIED NFPA 1917 AMBULANCE
Date of Manufacture _____
Mfg By _____
Address _____
City_____State_____Zip _____
This ambulance conforms to NFPA 1917 in effect on the date the ambulance was contracted for.
Final Stage Ambulance Manufacturers ID Number_____
VIN _____
OEM Chassis Model, Year of Manufacture _____
Vehicle Type _____
NOTICE: THIS VEHICLE, AS MANUFACTURED, CONFORMS TO THE PAYLOAD REQUIREMENTS OF THE FEDERAL AMBULANCE SPECIFICATION NFPA 1917. USERS SHALL NOT LOAD VEHICLES ABOVE THE GVWR, GAWRs OR EXCEED THE TOTAL USABLE PAYLOAD LISTED BELOW.
TOTAL USABLE PAYLOAD _____lbs.
(TOTAL REMAINING WEIGHT CAPACITY OF OCCUPANTS AND CARGO USER MAY ADD)

FIGURE 4.17.3.1 Certification and Payload Label.

4.17.4 Payload Calculation Form.
4.17.4.1* The completed payload calculation form in Figure 4.17.4.1 shall be provided in accordance with 4.17.3.
4.17.4.2 All text shown in Figure 4.17.4.1 shall be included.

[Have drawn as art]
CUSTOMER USABLE PAYLOAD INFORMATION
Final Stage Ambulance Manufacturer's Name:_____
OEM Chassis Year, Make, Model: _____
1) Ambulance Model, Type, Prod. #: _____

2) OEM GAWR – Front: _____ lb (kg)

3) OEM GAWR – Rear: _____lb (kg)

4) OEM GVWR: _____lb (kg)

5) Minimum Payload: _____lb (kg)

6) Curb Weight – AS BUILT – Front Axle: _____lb (kg)

7) Curb Weight – AS BUILT – Rear Axle: _____lb (kg)

8) Total Curb Weight – AS BUILT: _____lb (kg)

9) CUSTOMER USABLE Total Payload AS BUILT (item 4 minus item 8): _____lb (kg)

10) CUSTOMER USABLE Front Axle Payload AS BUILT (item 2 minus item 6): _____lb (kg)

11) Total Weight of Permanently mounted Options Specified (only required if item 9 does not meet or exceed item 5): _____lb (kg)

12) Payload of Basic Vehicle (item 9 plus item 11) (only required if item 9 does not meet or exceed item 5): _____lb (kg)

FIGURE 4.17.4.1 Payload Calculation Form.

4.18 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.

4.18.1 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

4.18.2 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.

4.18.3 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 estimated in-service weight during the design of the ambulance.

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

(1) The chassis and body
(2) Full fuel, lubricant, and other chassis or component fluid tanks or reservoirs
(3) Equipment load prescribed by the purchaser

(4) 171 lb (78 kg) in each designated seating position
(5) 171 lb (78 kg) to account for patient
(6) Patient cot
(7) 200 lb (91 kg) spare capacity

5.1.3 The manufacturer shall design the ambulance such that the completed ambulance, when loaded to its estimated in-service weight, with all movable weights distributed as close as is practical to their intended in-service configuration, does not exceed the GVWR or GAWRs.

5.1.4 Label.

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

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

5.2* Weight Distribution.

5.2.1 Longitudinal Weight Distribution.

5.2.1.1 When the ambulance is loaded to its estimated in-service weight, 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 estimated in-service weight, 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 gross axle weight ratings (GAWR), the overall gross vehicle weight rating (GVWR), and the chassis manufacturer's load balance guidelines.

5.3 Engine and Engine System Design.

5.3.1 Cold Start Performance Requirements.

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

5.3.1.2 Compliance shall be validated by testing a substantially similar ambulance in accordance with AMD 022, Cold Engine Start Test.

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

5.3.3 An engine hourmeter shall be provided.

5.3.4 Idle reduction engine shut-down 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 or throttle) 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 AMD 014, Engine Cooling System Test.

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 when these features are located on the same side of the vehicle.
5.6.4 If the ambulance is driven by a diesel engine equipped with a diesel particulate filter (DPF), the DPF shall not regenerate on its own unless the vehicle is in motion.

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 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:

(1) Approach angle 20 degrees
(2) Ramp breakover 10 degrees
(3) Departure angle 10 degrees

5.8.2* A traction control feature shall be provided.

5.8.3 Shock absorbers, double-acting type, heaviest duty available from OEM for model offered, 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 devices to ensure that the air system is provided with dry and protect the suspension control components.

5.9 Wheels and Tires.

5.9.1 Wheel/tire, hubs, and brake drum assemblies of the vehicle shall be dynamically balanced to a minimum of 70 mph (113 km/hr).

5.9.2 Hub caps or wheel covers shall not obscure the wheel nuts so that they can be readily observed for daily inspection.

5.9.3 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. Mud flaps may be incorporated into the running boards.

5.9.4 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.*

5.9.5 Bodies designed with wheel openings shall have the rear wheels centered, within +/- 2 in. (+/- 52 mm) of those openings.

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

5.10* Vehicle Stability.

The ambulance shall meet the requirements of either 5.10.1 or 5.10.2

5.10.1 The ambulance shall be 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.

5.10.2 The ambulance engine shall be governed to limit the top speed to 60 mph (97 km/hr).

5.11 Bumpers.

5.11.1* OEM's standard front bumper shall be furnished in the front of the chassis.

5.11.2 The rear of the ambulance shall be furnished with a full-width bumper.

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

5.11.2.2 Each rear bumper shall be provided with an integrated step.

5.11.2.3 The step shall be designed to prevent the accumulation of mud, ice, or snow and 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) are 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 Rear 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 nor more than 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 AMD 018, Rear Step and Bumper Static Load Test.
5.11.2.9 The height of the rear step shall not exceed 22 in. (559 mm) with the vehicle loaded to its estimated in-service weight and/or the suspension in the kneeling condition.

5.12 Cab Seal.
5.12.1 If the cab and patient compartment are separate enclosures, the cab shall be provided with a sealing device.
5.12.2 The seal shall be fabricated from a material resistant to ozone, sunlight, oil, and fungus.
5.12.3 The seal shall remain flexible in temperatures between -20°F (-29°C) and 110°F (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 Driver and front passenger seating shall consist of two individual bucket-type seats.
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 non-reclining 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 The mirrors shall be the largest available from the chassis OEM.
5.14.3 All primary side view mirrors used by the driver shall be adjustable from the driver's position.
5.14.4 Hardware and mirror heads shall have a corrosion resistant exterior finish.
5.15 Cab Integrity.
Cabs on ambulances with a GVWR greater than 26,000 lb (11,800 kg) shall meet the requirements of one of the following sets of standards:

(1) SAE J2420, *COE Frontal Strength Evaluation —– Dynamic Loading Heavy Trucks,* and SAE J2422, *Cab Roof Strength Evaluation —– Quasi-Static Loading Heavy Trucks*
(2) ECE Regulation number 29, *Uniform Provisions Concerning the Approval of Vehicles with Regard to the Protection of the Occupants of the Cab of a Commercial Vehicle*

6.1 Patient Compartment Configuration.

The patient compartment shall provide a minimum of 325 ft^3 (9.2 m^3) of space or 275 ft^3 (7.7 m^3) of space for a Type II, less volume for cabinets, while complying with 6.1.1 through 6.1.3.

6.1.1 A minimum of 10 in. (254 mm) shall be provided, from the rear edge of the cot mattress to the rear loading doors, to permit clearance for traction or long board splints.

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.

6.1.3 The patient compartment shall provide at least 60 in. (1.5 m) height, over the primary patient area, measured from floor to ceiling panels.

6.2 Mounting.

If the body is of a modular construction it shall be supported by full floating, automotive style, rubber body mounts.

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 AMD 001, Ambulance Body Structure Static Load Test.

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 AMD 001, Ambulance Body Structure Static Load Test.

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 AMD 001, Ambulance Body Structure Static Load Test.

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

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

6.4 Body Structural Integrity – Side Loading.

6.4.1 Any Type I ambulance body shall withstand a force equal to 2.5 times the curb weight of the vehicle applied to either the driver or passenger side of the vehicle's body structure validated by testing a substantially similar ambulance in accordance with AMD 001, Ambulance Body Structure Static Load Test.

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 AMD 001, Ambulance Body Structure Static Load Test.

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

6.4.4 The rear doors of the vehicle shall be capable of opening and closing during the full application of the force and after release of the force.

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

6.5 Body Sealing.

6.5.1 Sealing Out Water.

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

6.5.1.2 Compliance of the body sealing out water shall be validated by testing a substantially similar ambulance in accordance with AMD 010, Water Spray Test.

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 10 ppm of CO above ambient conditions.

6.5.2.2 The patient compartment shall include a carbon monoxide detector.

6.6 Wheel Housings.

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

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

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

6.7 Patient Compartment to Cab Partition.

6.7.1 Where a bulkhead partition is provided it shall be placed between the driver and patient's compartment.

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

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

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

6.7.5 The ambulance and body bulkheads shall have an aligned window opening of at least 150 $in.^2$ (139 mm^2) or other means of visual and hands free audio communication.

6.7.6 If equipped with a window in the cab or body it shall be of the sliding type, shall be aligned, and connect 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, noncorrosive material.

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

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

6.8.5 Handrails and handholds shall be constructed so that three points of contact (two hands and one foot, or one hand and two feet) can be maintained at all times while ascending and descending.

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

6.8.7 Handrail Testing.

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

6.8.7.2 Compliance of the handrail shall be validated by testing a substantially similar ambulance or body structure in accordance with AMD 008, Patient Compartment Grab Rail Static Load Test.

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 Doors shall be designed to minimize inadvertent snagging of apparel.

6.9.3 Door latches, hinges, and hardware furnished by OEM and 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 $in.^2$ (161.3 m^2) of safety glass area per door.

6.9.10 Doors shall be sealed to prevent leakage of exhaust fumes, dust, water, and air.

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 to AMD 002, Body Door Retention Components Test.

Table 6.9.11 Loads Withstood on Ambulance Door Latches and Hinges

	Side Door		Rear Door	
	Transverse Load	Longitudinal Load	Transverse Load	Longitudinal Load
Fully Latched Position	2500	2500	2500	2500
Secondary Latched Position	1500	1500	1500	1500
Hinge	2500	2500	2500	2500

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

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

(1) Open at any time during the test procedure

(2) Fail at the latch, striker(s), hinge, or their points of attachment to the door or the body framework

6.10 Means of Escape.

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

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

6.11 Steps.

6.11.1 Steps shall be provided in the door openings.

6.11.2 Height of the bottom step shall not exceed 22 in. (559 mm).

6.11.3 Step wells shall be illuminated.

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

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

6.12 Exterior Stepping Surfaces.

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.

6.13 Exterior Storage.

6.13.1 Exterior storage shall be furnished for all equipment specified by the purchaser.

6.13.2 Exterior storage compartments shall be weather resistant.

6.13.3 Doors shall provide secure closure properties.

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

6.13.5 Hardware (hinges, locks, latches, etc.) shall be rust resistant.

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

6.13.7 If key locks are provided they shall be keyed alike.

6.13.8 All exterior compartments greater than 4 ft^3 (0.11 m^3) shall be automatically illuminated when opened.

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

6.14 Floor.

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

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

6.14.3 The sub floor of the modular body patient compartment shall be designed to prevent water penetration.

6.14.4 The sub floor of the modular body shall include a heat shield.

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

6.14.6 The sub floor construction shall cover the full length and width of the patient compartment.

6.14.7 The sub floor of the patient compartment shall be not less than 0.5 in. (13 mm) thick.

6.14.8 The sub floor material shall be non-hygroscopic.

6.14.9 If plywood is used in the sub floor it shall be marine or exterior grade.

6.14.10 Body Floor Structural Integrity.

6.14.10.1 Sub floor shall have an American Plywood Association (APA) floor rating of 16 in. (406 mm) on center or shall be tested using a 3 in. (76 mm) disk, having a maximum of 0.125 in. (3 mm) deflection at 200 pounds (91 kg) force, and an ultimate load of 400 lbs (181 kg).

6.14.10.2 In the case where the floor structure spacing is greater than 16 in. (406 mm) on center or a non-rated material is used; the maximum floor structure spacing shall be used for testing.

6.14.10.3 Compliance of the floor structural integrity shall be validated by testing the mid-point of the longest unsupported section of a substantially similar ambulance or floor structure in accordance with the concentrated static load test procedure in ASTM E661.

6.15 Floor Covering.
6.15.1 Floor covering shall be non permeable, seamless and easily cleaned.
6.15.2 The floor covering shall cover the entire length and width of the compartment's working area. The covering of joints (corners, etc.), where the sidewalls and covering meet, shall be sealed and bordered with corrosion resistant cove molding or the covering shall extend at least 3 in. (76 mm) up the sidewalls.
6.16 Insulation.
6.16.1 Where the patient compartment is insulated it shall be insulated with a non-settling type, vermin-proof, mildew-proof, fire retardant, non-toxic, and non-hygroscopic.
6.16.2 If fiberglass insulation is used, it shall be protected from exposure to water.
6.17* Interior Storage.
6.17.1 The interior of the patient compartment shall provide a minimum volume of 30 ft^3 (0.85 m^3) of enclosed storage cabinetry, compartment space, and shelf space.
6.17.2 Compartment(s) under the floor, with opening panel(s) inside the patient compartment, shall not be acceptable.
6.17.3 When furnished, top opening squad bench lids shall be fitted with an automatic hold open device and a quick release slam type latching device when closed.
6.17.4 All interior systems, components and permanently attached equipment shall function satisfactorily over a temperature range of 32°F (0°C) to 95°F (35°C).
6.17.4.1 Compliance of the equipment function shall be validated by testing a substantially similar ambulance in accordance with AMD 011, Equipment Temperature Test.
6.17.4.2 The ambulance and all systems, components and equipment shall be capable of being stored at 32°F (0°C) to 95°F (35°C) without damage or deterioration.
6.17.5 Storage compartment doors shall be provided with low profile handles.
6.17.6 Storage compartments shall be divided into sections.
6.17.7 Drawer slides shall be self-locking.
6.17.8 Shelves shall be removable.
6.17.9 Doors shall remain closed during transport.
6.17.10 Storage compartments shall be firmly fastened to the body structure.
6.18 *Cabinet Measuring.
6.19 Interior Surfaces.
6.19.1 The interior of the body shall be free of all sharp projections and sharp corners.
6.19.2 All hangers or supports for equipment and devices shall be mounted as flush as possible with the surrounding surface.
6.19.3 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

6.19.4 Counter tops and shelves shall be surrounded by a lip of not less than 0.5 in. (13 mm) in height.
6.19.5 Counter top horizontal surface shall be seamless and impervious to contaminates.
6.19.6 All edges that meet vertical cabinets shall be sealed.
6.20 Equipment Mounting.
Supplies, devices, tools, etc., shall be stored in enclosed compartments or fastened to secure them during vehicle motion.
6.21 Waste and Sharps Disposal.
A receptacle for general waste and an OSHA compliant container for sharps disposal shall be provided in the patient compartment.

6.22 Holder For Intravenous Fluid Containers.
6.22.1 One ceiling mounted "hook" style device specifically designed for holding IV containers shall be provided, including hook and loop straps to adequately secure an IV bag/bottle.
6.22.2 The device shall not protrude more than 1.0 in. (25 mm).
6.23 Personnel Capacity.
A label that states the maximum number of occupants the vehicle is designed to carry shall be located in an area visible to the driver.

6.24 Patient Compartment Seats.

6.24.1 Seat Integrity.

Any independent seat with integrated belt system (ABTS) shall be dynamically tested by the seat manufacturer in accordance with FMVSS 208 for any locked orientation in which it will be installed.

6.24.2* SCBA Storage.

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

6.24.3 Seat Belts.

6.24.3.1* Each crew riding position shall be provided with a seat belt.

6.24.3.2 Ambulances above 19,500 lb (8,845 kg) GVWR shall provide seat belts in accordance with 6.24.3.2.1 and 6.24.3.2.2.

6.24.3.2.1 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:

(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 (line 1 in Figure 6.24.3.2.1). For seats with an SCBA seat back, use a plane that simulates the position of an SCBA back pad installed in the SCBA holder.
(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. Record this length as AD.
(6) Measure from point C to point D and record this length as CD.
(7) The effective seat belt web length equals AD + CD.

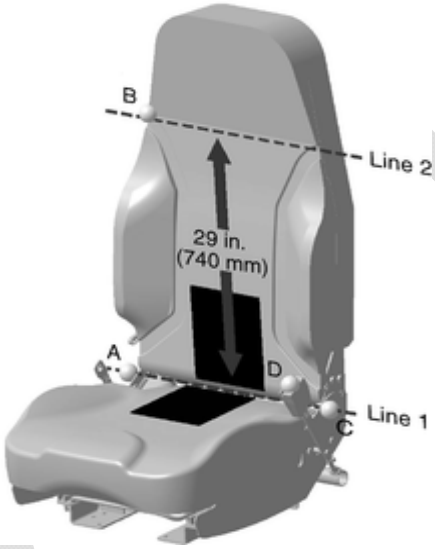


FIGURE 6.24.3.2.1 Dimension Lines for Measuring Seat Belt Effective Length.

6.24.3.2.2 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 (line 1 in Figure 6.24.3.2.1). For seats with an SCBA seat back, use a plane that simulates the position of an SCBA back pad installed in the SCBA holder.
(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 (line 2 in Figure 6.24.3.2.1).
(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. Record this length as AB.
(8) Measure from point C to point D and record this length as CD.

(9) The effective seat belt web length equals AB + 2CD.

6.24.4 Seated Head Clearance.

6.24.4.1 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).

6.24.4.2 The measurement shall be in accordance with AMD 025, Measurement Guidelines: Occupant Head Clearance Zones.

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

6.24.5 Seating Position Width.

Each designated seating space in vehicles greater than 10,000 lb (4,500 kg) GVWR shall have a minimum width of 24 in. (610 mm) at the shoulder height.

6.24.6 Seat Size.

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

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

6.24.6.3 A back cushion that extends from the face of the seat vertically at least 7.0 in. (460 mm) and that is a minimum of 18 in. (460 mm) wide at the base shall be provided.

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

6.24.6.5 The top of the seat back or head rest shall be a minimum of 10 in. (254 mm) in width.

6.24.7 Access to Patient.

6.24.7.1 If the designated Primary Patient Care Seat is the Patient Torso Position it shall be capable of being adjusted such that the nearest edge of the seat bottom cushion can be positioned no less than 6 in. (152 mm) from the nearest edge of the Patient Cot.

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

6.24.7.3 If the designated Primary Patient Care Seat is the Patient Head Position it shall be capable of being adjusted such that the nearest edge of the seat bottom cushion positioned no less than 6 in. (152 mm) from the nearest edge of the Patient Cot.

6.24.7.4 The longitudinal centerline of the seat shall line up within 11 in. (280 mm) of the longitudinal centerline of the cot.

6.24.8 Child Seating Restraints.

6.24.8.1 Any seat capable of transporting a child or infant shall not be oriented in a side facing direction during transport.

6.24.8.2 If the purchaser specifies that the ambulance will transport infants in a seat it shall include an Infant Restraint Seat or have provisions to accommodate an infant seat.

6.24.8.3 If the purchaser specifies that the ambulance will transport children in a seat it shall include a Child Restraint Seat or have provisions to accommodate a child seat.

6.25 Patient Cot Retention.

6.25.1 Each Patient Cot retention system shall not fail or release when subjected to the cot manufacturers recommended load or a minimum force of 2,200 lb (998 kg) applied in the longitudinal, lateral, and vertical direction.

6.25.2 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 AMD 004, Litter Retention System Static Test.

6.26 Seat Belt Indication.

6.26.1 Signs that read “Occupants Must be Seated and Belted When Ambulance Is in Motion” shall be visible from each seated position.

6.26.2 A seat belt warning system shall be provided.

6.26.3 The warning system shall consist of an audible warning device that can be heard at all seating positions designed to be occupied while the vehicle is in motion and a visual display visible to the driver showing the condition of each seating position.

6.26.4 The warning shall be activated anytime the parking brake is released or the automatic transmission is not in park.

6.26.5 The seat position display shall indicate conditions in accordance with Table 6.26.5.

Table 6.26.5 Display for Seating System

Display Indication	Seat Belt	Seat Sensor

Affirmative indication	Buckled	Senses occupant
Negative indication	Buckled	No occupant
Negative indication	Unbuckled	Senses occupant
Dark	Unbuckled	No occupant

6.26.6 The display indication shall be permitted to consist of lights, text, graphical indicators, digital displays, or other methods.
6.26.7 The warning system shall not show an affirmative indication unless it has determined that the seat was occupied before the seat belt was buckled.
6.27 HVAC.
6.27.1 HVAC units shall be independently controlled between the driving and patient compartments.
6.27.2 Connecting hoses for heating and the air conditioning system shall be supported by rubber-insulated metal clamping devices at least every 18 in. (457 mm).
6.27.3 Heating.
6.27.3.1 A heating system shall be provided capable of raising the interior temperature from 32° F to 68°F (0°C to 20°C) within 30 minutes.
6.27.3.2 Compliance of the heating system shall be validated by testing a substantially similar ambulance in accordance with AMD 012, Interior Climate Control Test.
6.27.4 Air Conditioning.
6.27.4.1 An air conditioning system shall be provided 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.
6.27.4.2 Compliance of the air conditioning system shall be validated by testing a substantially similar ambulance in accordance with AMD 012, Interior Climate Control Test.
6.27.5 Ventilation.
6.27.5.1 Ventilation system(s) of the driver and patient compartments shall provide a change of ambient air within both compartments with the vehicle stationary.
6.27.5.2 Ventilation shall be separately controlled within the cab and patient compartments.
6.27.5.3 Fresh air intakes shall not be located near the engine exhaust outlet.
6.27.5.4 Fresh air exhaust fan shall provide a minimum of 400 cfm (11 m^3/min).
6.28 Interior Noise.
6.28.1 The interior sound level in the patient compartment shall not exceed 80 decibels.
6.28.2 Compliance of the patient compartment interior sound shall be validated by testing a substantially similar ambulance in accordance with AMD 006, Patient Compartment Sound Level Test.
6.29* Reflective Striping.
6.29.1* 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 apparatus visible when approaching from the front.
(2) 50 percent of the over-all ambulance length visible when approaching from each side

6.29.1.1 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.
6.29.1.2 Each stripe in the chevron shall be a single color alternating between red and either yellow, fluorescent yellow, or fluorescent yellow-green.
6.29.1.3 Each stripe shall be 6 in. (150 mm) in width.
6.29.2 The stripe or combination of stripes shall be a minimum of 4 in. (100 mm) in total vertical width.
6.29.3 The 4 in. (100 mm) wide stripe or combination of stripes shall be permitted to be interrupted by objects (i.e., receptacles, cracks between slats in roll up doors, and so forth) provided the full stripe is seen as conspicuous when approaching the apparatus.
6.29.4 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 6.29.1.
6.29.5 Any vertically hinged door shall have at least 60 $in.^2$ (38710 mm^2) of retroreflective material affixed to the inside of the door.
6.29.6 All retroreflective 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.

6.29.7 All retroreflective materials that are colors not listed in ASTM D 4956, Section 6.1.1, shall have a minimum coefficient of retroreflection of 10 with observation angle of 0.2 degrees and entrance angle of -4 degrees.
6.29.8 Any printed or processed retroreflective film construction shall conform to the standards required of an integral colored film as specified in ASTM D 4956, Section 6.1.1.

6.30 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.

6.31 Painting.

6.31.1 All exposed ferrous metal surfaces that are not plated or stainless steel shall be cleaned and prepared and shall be painted or coated.
6.31.2 The paint or coating, including any primer, shall be applied in accordance with the paint or coating manufacturer's recommendation.

6.32 Oxygen, Main Supply and Installation.

6.32.1 The ambulance shall have a piped medical oxygen system capable of storing and supplying a minimum of 3,000 liters of medical oxygen.
6.32.2 The main oxygen supply shall be from a compressed gas cylinder(s) that the purchaser will provide and install at the time the vehicle is placed in service.
6.32.3 A cylinder changing wrench shall be furnished.
6.32.4 The wrench shall be tethered and secured within the oxygen cylinder compartment.
6.32.5 The cylinder controls shall be accessible from the inside the vehicle.
6.32.6 A cylinder pressure indication device shall be visible from the designated primary patient care seating position.
6.32.7 The oxygen outlet shall be accessible from the designated primary patient care seating position
6.32.8 The purchaser shall specify the type of oxygen outlet .
6.32.9 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 shall be concealed and not exposed to the elements, securely supported to prevent damage, and be readily accessible for inspection and replacement.
(4) Oxygen shall be piped to a self-sealing oxygen outlet with a minimum flow rate of 100 LPM at the outlet.
(5) Outlet(s) shall be marked and identified and not interfere with the suction outlet

6.32.10 Oxygen Pressure Regulator.

6.32.10.1 The medical, oxygen pressure reducing, and regulating valve with inlet filter at the cylinder shall be provided with the following features:

1) Line relief valve set at 200 psi (1380 kPa) maximum
2) Gauge or digital monitor with a minimum range of 0 to 2,500 psi (17,237 kPa)
3) Gauge scale or digital monitor display graduated in not more than 100 psi (690 kPa) increments.
4) Locking adjustment, at 50 +/- 2 psi line pressure.
5) Regulator performance as required at an inlet pressure range from 150 psi to 2,500 psi (1,034 kPa to 17,237 kPa).

6.32.10.2 With the regulator set at 50 +/- 2 psi, a 100 LPM minimum flow rate shall be available at all oxygen outlets.

6.32.11 Oxygen Tank Storage.

6.32.11.1 Storage for the main oxygen cylinder shall be accessible for replacement from an outside position.
6.32.11.2 The oxygen compartment shall be provided with at least a 9 $in.^2$ (580 mm^2) of open vent to dissipate/vent leaking oxygen to the outside of the ambulance.
6.32.11.3 Oxygen cylinder compartment shall not be utilized for storage of any other equipment and shall be labeled "Oxygen Storage Only".

6.32.12 Oxygen Tank Retention.

6.32.12.1 Any oxygen tank shall be retained to withstand a force equal to 25 times the weight of a full tank for which the tank holder was designed.
6.32.12.2 The oxygen tank holder components shall not fail or separate along attachment points.
6.32.12.3 The oxygen tank holder or any component thereof shall not separate from the vehicle at any attachment point.
6.32.12.4 The part of the vehicle to which the oxygen tank holder is attached shall not fail and/or separate at any

attachment point.
6.32.12.5 The simulated cylinder shall not disengage from the oxygen tank holder.
6.32.12.6 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 AMD 003, Oxygen Tank Retention System Static Test.
6.32.13 Oxygen System Integrity.
6.32.13.1 Each ambulance equipped with an oxygen system shall be tested prior to delivery.
6.32.13.1.1 The oxygen system shall lose no more than 5 psi (34 kPa) of pressure in a 2 hour period.
6.32.13.1.2 Oxygen flow through each outlet shall be capable of delivering at least 100 LPM of oxygen.
6.32.13.1.3 Compliance of the oxygen system integrity shall be validated by testing a sample system in a substantially similar ambulance in accordance with AMD 015, Ambulance Main Oxygen System Test.
6.32.13.2 A label shall be provided near the oxygen tank stating: "This oxygen system was tested in accordance with NFPA 1917 and meets the requirements thereof".
6.32.13.3 This label shall be signed and dated by an authorized representative of the ambulance manufacturer or test agency.
6.33 Suction Aspirator.
6.33.1 An electrically powered suction aspirator system shall be furnished.
6.33.2 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.
6.33.3 The aspirator system shall be wired in accordance with Figure 6.33.3.

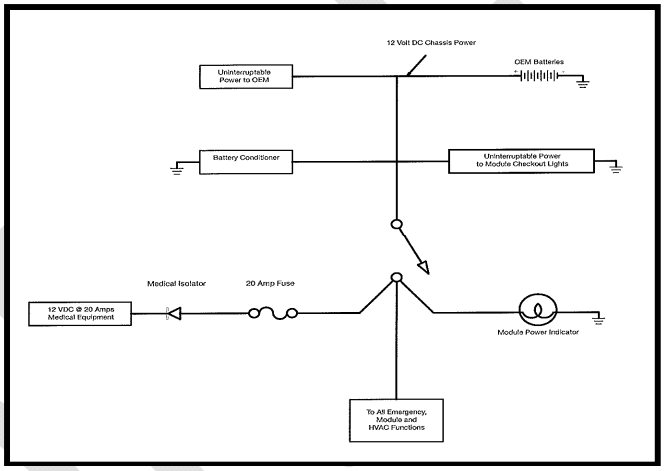


Figure 6.33.3 Aspirator System Wiring

6.33.4 The suction pump shall be located in an area that is accessible and insulated from the patient compartment.
6.33.5 The pump, when permanently mounted, shall be vented to the vehicle's exterior.
6.33.6 A vacuum control and a shut-off valve, or combination thereof, shall be provided to adjust vacuum levels.
6.33.7 A vacuum indicator gauge graduated at least every 100 mm Hg and a minimum total range of 0 to 760 mm Hg shall be provided.
6.33.8 The collection bottle or bag shall be shatter resistant and transparent with a minimum 1,000 mL capacity.
6.33.9 The minimum inside diameter for the suction tubing connectors shall be at least 1/4 in. (6.4 mm).
6.33.10 The end user shall provide any suctioning catheters desired.
6.33.11 Aspirator System Performance.
6.33.11.1 If an aspirator system is provided, it shall provide a free airflow of at least 30 Lpm.
6.33.11.2 If an aspirator system is provided, it shall achieve a minimum of 300 mm Hg vacuum within 4 seconds after the suction tube is closed.
6.33.11.3 Compliance of the aspirator system shall be validated by testing a sample aspirator system installed in a substantially similar ambulance in accordance with AMD 021, Primary Patient Aspirator System Test.

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 standards, "Acceptability of Electronic Assemblies."
7.1.1.2 Printed circuit assemblies provided shall qualify under Classification 1.4.1 as class 3 for "Life Support or other Critical Assemblies."
7.1.1.3 Printed circuit board connections and components shall conform to all other specification requirements.
7.1.2 Electrical System Performance Tests.
The low voltage electrical system performance test shall be done according to Section 9.1

7.2 Wiring.
7.2.1 All electrical circuit feeder wiring supplied and installed by the ambulance manufacturer shall meet the requirements of 7.2.1.1 through 7.2.1.6.
7.2.1.1* The circuit feeder wire shall be stranded copper or copper alloy conductors of a gauge rated to carry 125 percent of the maximum current for which the circuit is protected.

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

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

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

7.2.1.5 Electrical wiring and components shall not terminate in the oxygen storage compartment except for the oxygen controlled solenoid, compartment light, and switch plunger or trigger device.

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

7.2.2 Wiring and Wire Harness Construction.

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

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

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

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

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

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

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

electrical connection.

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

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

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

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

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

7.2.2.8 Wiring Protection.

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

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

7.2.2.9* Wiring Identification.

7.2.2.9.1 Wiring shall be uniquely identified at least every 2 ft (0.6 m) by color coding or permanent marking with a circuit function code.

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

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

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

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

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

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

7.2.2.11 Terminals.

7.2.2.11.1 All terminals shall be permanently numbered or coded.

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

7.2.2.12 The ambulance electrical system shall incorporate a master circuit breaker panel with circuit breakers or other electronic, non-disposable, current protection devices, in each circuit, which comply with SAE J553 Type I, or Type III (if circuit breaker is readily accessible for resetting by the driver or EMSP).

7.2.2.13 One extra 15 amp circuit breaker shall be provided for future use.

7.2.2.14 Grounding.

7.2.2.14.1 Dedicated grounds for all appliances, circuits, etc. shall be furnished.

7.2.2.14.2 The use of appliance mounting screws/hardware shall not be used for grounding purposes.

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

and servicing.

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

7.2.2.17 The ambulance body and accessory electrical equipment shall be served by circuit(s) separate and distinct from vehicle chassis circuits.

7.3 Power Supply.

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

7.3.2* Low Idle Alternator Output.

7.3.2.1 The alternator shall have a minimum output at low idle to meet the minimum continuous electrical load of the ambulance at 95°F (35° C) ambient temperature.

7.3.2.2 Compliance of the low idle alternator output 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 full system electrical load at 95°F (35°C) ambient temperature.

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

7.4 Minimum Continuous Electrical Load.

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

(1) The propulsion engine and transmission
(2) All legally required clearance and marker lights, headlights, and other electrical devices except windshield wipers and four-way hazard flashers
(3) The radio(s) at a duty cycle of 10 percent transmit and 90 percent receive (for calculation and testing purposes, a default value of 5 A continuous)
(4) The lighting necessary to 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 amp load.
(7) Cab air conditioning (at coldest setting with highest blower speed).
(8) Patient module air conditioning (at coldest setting with highest blower speed).
(9) Patient module 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 amps shall be added to the minimum continuous electrical load to provide electrical power for the federally required clearance and marker lighting and the optical warning devices mounted on the trailer.

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

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

7.4.3.2 Voltage Alarm.

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

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

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

7.5 Load Management.

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

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

7.5.3 An Engine High-Idle speed control shall be furnished.
7.5.3.1 The control shall be set to automatically increase the engine speed (RPM) to the engine manufacturer's recommended setting to sustain the ambulance's total continuous electrical load at the regulated voltage and provide maximum heating/air conditioning output.

7.5.3.2 The device shall operate only when switched to the "ON" position and the transmission is in "PARK" or "NEUTRAL."
7.5.3.3 The parking brake shall be applied at all times when the Engine High-Idle speed control is in use.

7.5.3.4 The device shall disengage high idle operation according to the chassis manufacturer's and/or engine manufacturer's disablement strategy, or if not specified, when the operator depresses the service brake pedal, the parking brake is released or the transmission is placed in gear.

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 continuous electrical load for 10 minutes without discharging more than 50 percent of the reserve capacity and then to restart the engine.

7.6.1.2 Compliance of the battery system shall be verified on every ambulance prior to delivery in accordance with 9.5.2.2.

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

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.

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.

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

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 Line voltage systems.

7.6.7* A master load disconnect switch 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 batteries.

7.6.8.2 Electronic control systems and similar devices shall be permitted to be otherwise connected if so specified by their manufacturer.
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.

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.
7.6.11 Two automotive "Power Point" type connectors shall be furnished in the patient compartment for charging all portable battery powered devices (i.e. suction units, hand lights, defibrillators, portable radios, etc.).
7.6.11.1 The "Power Point" circuits shall prevent discharge of chassis batteries by only permitting the charging of portable devices when the vehicle is either running 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 to isolate medical equipment batteries from any electrical loads that the remainder of the ambulance electrical system may impose.
7.6.11.3.1 The "Schottky" diode 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 The diode 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 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.
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).*

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.

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.

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

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

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

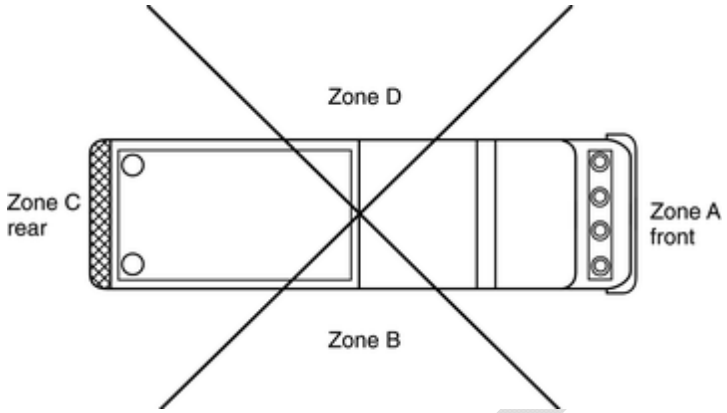


FIGURE 7.9.3.2 Warning Zones for Optical Warning Devices.

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.

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

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

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

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

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

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

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

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

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

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

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

7.9.11 Flash Rate.

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

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

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

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

7.9.12* Color of Warning Lights.

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

Table 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

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

7.9.13* Requirements for Large ambulances.

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

7.9.13.2 Upper-Level Optical Warning Devices.

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

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

7.9.13.3 Lower-Level Optical Warning Devices.

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

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

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

7.9.13.4 Midship Optical Warning Devices.

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

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

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

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

Table 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:

1. All values are in candela-seconds/minute.
2. *H* = Horizontal plane passing through the optical center.
3. The values in the *H* Total columns are the total of 19 data point values for each light, with data points on the boundary between zones counted in both zones.

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

7.9.14* Requirements for Small Ambulances.

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

7.9.14.2 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.

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

7.9.14.3 Lower-Level Optical Warning Devices.

7.9.14.3.1 One or more lower-level optical warning devices shall be visible from the front and the side of the ambulance

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

7.9.14.3.3 The optical center of the device(s) shall be between 18 in. and 48 in. (460 mm and 1,220 mm) above level ground.

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

Table 7.9.14.4 Minimum Optical Power Requirements for Small Ambulance

Zone	Mode of Operation					
	Calling for Right-of-Way			Blocking Right-of-Way		
	***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:

1. All values are in candela-seconds/minute.
2. *H* = Horizontal plane passing through the optical center.
3. The values in the *H* Total columns are the total of 19 data point values for each light, with data points on the boundary between zones counted in both zones.

7.9.14.5 No individual measurement point shall be less than that shown in Table 7.9.14.4.

7.9.15 Tests of Optical Warning Devices.

7.9.15.1 Mechanical and Environmental Test.

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

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

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

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

7.9.15.2 Photometric Test Procedures for Optical Devices.

7.9.15.2.1 Testing shall be performed by, or on behalf of, the device manufacturer to ensure compliance with the requirements of 7.9.15.2.2 through 7.9.15.2.5.2.

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.

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*.

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.

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

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

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

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

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

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

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

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

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

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

(1) Certification that the system was installed within the geometric parameters specified by the manufacturer of the system referencing the optical source test reports provided by the manufacturer of the system
(2) Certification that a mathematical calculation based on test reports for individual optical sources provided by the manufacturer of the 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 Approved Lighting Systems.

7.9.17.1 An emergency lighting system shall provide the ambulance with 360° 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 message in the "PRIMARY MODE" — "Clear the Right-of-Way" and 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 Warning light systems shall not impair the effectiveness of the ambulance's exterior lighting with conformity to the requirements of FMVSS No. 108.

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

7.9.17.2.1 These lights shall function in a dual mode system as shown in Table 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.

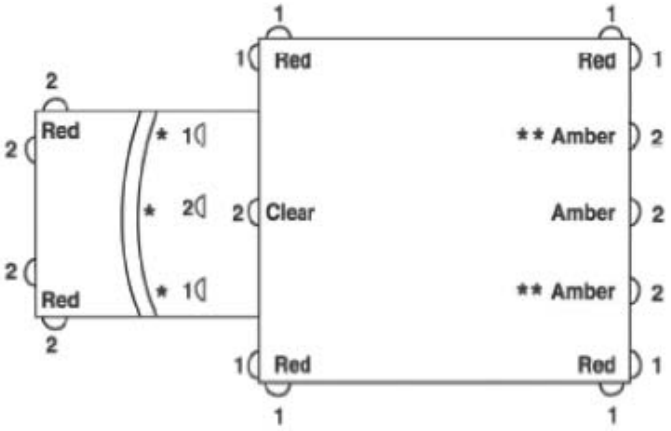
7.9.17.2.5 The amber light shall be symmetrically located between the two rear facing red lights.

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 may 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.

Table 7.9.17.2.1– Emergency Lighting



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	GRILL & 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	Grille and Fender
PRIMARY "Clear the Right-of-Way"	ON	ON	ON	ON
SECONDARY "Hazard-Vehicle Stopped on Right-of-Way""	ON	OFF	ON	OFF

7.9.17.3 Photometric, Chromaticity, and Physical Requirements.
7.9.17.3.1 Each emergency light shall flash 75 to 125 times per minute.
7.9.17.3.2 The chromaticity values of the lights shall conform to SAE J578, for their respective color, except for the red lights, which may conform to the following expanded boundary limits of: y =0.34; y = 0.32; 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 H-V.

7.9.17.3.4 Each light shall produce flash energy, (Cd-s) per flash, measured from the H-V to all the extreme test point coordinates and shall be tested at all 5 degree increments.
7.9.17.3.4.1 At no point shall the Cd-s values drop to less than the minimum values as shown in Table 7.9.17.2.1 when tested at 14.2 volts.
7.9.17.3.4.2 Flash energy shall be determined in accordance with the SAE J845 method for determining the flash energy of a light.
7.9.17.3.5 Testing shall be conducted on the device(s) as manufactured including use of the actual light source and all other related system components.
7.9.17.4 The emergency light switches shall be wired and arranged to provide the warning light signal modes and combinations as specified.
7.9.17.4.1 All emergency light switches shall be labeled and each Primary/ Secondary mode switch shall have 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, J576, J578, and J551, 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 include aiming wedges to compensate for sloped body surfaces, grill, hood and fender angles or mold release angles on roof caps.
7.9.17.5.2 The manufacturer shall aim the lights to assure 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° to -3°.
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 other 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, 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 which 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 this specification.

7.10 Audible Warning Devices.

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

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

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

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

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

7.10.4 The siren, with the exception of cancellation effects due to dual speakers, when tested in a full anechoic chamber with test equipment and methods, shall conform to California Administrative Code, Title 13, Article 8:
7.10.4.1 The siren shall be capable of producing a continuous warning sound at a minimum level of 123 dB, A-weighted, at 3 m (10 ft) on axis in the "wail mode" with "yelp" falling within 1 dB with 13.6 volts +/- 1% input, at a fundamental frequency in the range of 500 Hz to 2000 Hz maximum.
7.10.4.2 The output over the sweep range shall not drop to less than 116 dB.

7.10.4.3 The speakers shall be located in the configuration that is representative of the vehicle on which they will be mounted.
7.10.4.4 In the "wail" mode, the siren shall have a sweep rate of 10 to 18 cycles per minute and in the "yelp" mode, a sweep rate of 150 to 250 cycles per minute.
7.10.4.5 All sweep modes shall cover a range of at least one octave.
7.10.4.6 In voice (P.A.) operation, the unclipped sine wave output shall be at least 55 watts RMS into a resistive load matching the nominal speaker system impedance at 1,000 Hz.
7.10.4.6.1 The frequency response of the amplifier shall be from 500 Hz to 3,000 Hz +/- 3 dB, when measured from 1000 Hz reference.
7.10.4.6.2 Total harmonic distortion shall not exceed 10 percent, at 20 watts RMS, over the specified frequency range when measured with the load shown above.
7.10.4.7 The electronic siren shall be tested, approved and listed with the Automotive Manufacturers Equipment Compliance Agency.

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 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 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 AMD 024, Perimeter Illumination Test.
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 running lights and 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 amps and shall have separately protected and controlled circuits.
7.11.6.3.3 All interior lighting fixture shall not protrude more than 1.5 in. (38 mm) from the mounting surface.
7.11.6.3.4 The patient compartment lighting shall have a minimum of two levels of lighting, high and low.
7.11.6.3.4.1 In the high setting the patient compartment floor shall not be less than 15 foot candles intensity, measured along the centerline of the clear floor.
(A) Compliance of the patient compartment floor illumination shall be validated by testing a substantially similar ambulance in accordance with AMD 016, Patient Compartment Lighting Test.

7.11.6.2.4.2* The primary cot, in the high setting, shall be provided with a minimum of 35 foot candles of illumination measured on at least 90 percent of the cot's surface area.
(A) Compliance of the patient cot illumination shall be validated by testing a substantially similar ambulance in accordance with AMD 016, Patient Compartment Lighting Test.
7.11.6.2.4.3 The patient compartment lighting (in the low setting) shall be automatically activated when the side entry or rear entry patient compartment doors are opened.
7.11.6.2.5 Compliance of lights activated by the side entry door and rear entry door shall be validated by testing a substantially similar ambulance in accordance with AMD 016, Patient Compartment Lighting Test.
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 Each step well shall be illuminated when door is open to a minimum of 1 fc on 90 percent of the step.

7.11.9 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 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 7.13.1.

(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 equipped with a do-not-move ambulance light it shall be labeled to read "Do Not Move Ambulance When Light Is On."

7.13* Backup Alarm.

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

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 12V power and ground shall be provided.

Chapter 8 Line Voltage Electrical Systems

8.1 Application.

The ambulance shall be furnished with a 2-wire plus ground line voltage (AC)wiring system which shall meet, the applicable requirements of this chapter.

8.2 General Requirements.

8.2.1 Line Voltage Utility Power Listing shall be by a nationally recognized testing laboratory, recognized by OSHA under Appendix A to 29 CFR 1910.7.

8.2.1.1 The AC system is to be utilized while the vehicle is stationary for powering maintenance devices, medical equipment and battery chargers.

8.2.1.2 The AC system shall not be utilized for operational ambulance interior lighting, such as patient compartment lights.

8.2.2 Line Voltage Supplied from an External Source.

8.2.2.1* The ambulance shall be equipped with a fixed power inlet (shoreline inlet), it shall be a permanently mounted inlet (male-recessed type with cover), with a minimum rating of 15 amperes conforming to NEMA configuration, and wired directly to the system or device to be powered or wired to a transfer switch where required by 8.8.2.

8.2.2.2 The shoreline inlet shall be equipped with spring loaded cover assembly suitable for wet locations.

8.2.2.3 The connection shall be permanently labeled as shown in Figure 8.2.2.3.

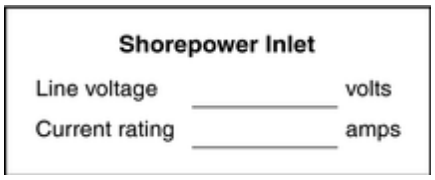


FIGURE 8.2.2.3 Shorepower Inlet Label.

8.2.2.4 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 (utility power).

8.2.3.2 A proper mating, weatherproof, minimum15 ampere connector body conforming to NEMA configuration shall also be furnished without cable and tagged specifying the size, type of wire necessary, and the polarity of the future hookup.

8.2.4 Stability.

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

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

8.2.4.3 The maximum voltage supplied to portable equipment shall not exceed 125 volts to ground.

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

8.2.5 Conformance with *National Electrical Code*.

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

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

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

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

8.2.6 Location Ratings.

8.2.6.1 Any equipment used in a dry location shall be listed for dry locations.

8.2.6.2 Any equipment used in a wet location shall be listed for wet locations.

8.2.6.3 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.

8.2.6.4* 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.

8.2.7 Line Voltage Electrical System Testing.

Electrical System Testing shall be performed according to Section 9.2.

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*.
8.3.1.2 Grounding shall be in accordance with Section 250-6 [Portable and Vehicle Mounted Generators] of the National Electrical Code (NEC).
8.3.1.3 Ungrounded systems shall not be used.
8.3.1.4* Only stranded copper with green colored insulation or green with yellow tracer insulation or braided copper conductors shall be used for grounding and bonding.
8.3.1.5 The grounded current-carrying conductor (neutral) shall be insulated from the equipment-grounding conductors and from the equipment enclosures and other grounded parts.
8.3.1.6 The neutral conductor shall have white or gray colored insulation in accordance with 200.6, "Means of Identifying Grounded Conductors," of *NFPA 70*.
8.3.1.7 Any bonding screws, straps, or buses in the distribution panelboard or in other system components between the neutral and equipment-grounding conductor shall be removed and discarded.

8.3.2 Interior Equipment Grounding.

8.3.2.1 In the line voltage electrical system, all exposed metal parts, enclosures, frames, fixtures, canopies, etc., shall be effectively bonded to the grounding terminals or enclosure of the distribution panel board.
8.3.2.2 Grounding of electrical equipment shall be done as required in 8.3.2.2.1 through 8.3.2.2.6.

8.3.2.2.1 Connection of metal raceway, i.e., conduit or electrical metallic tubing.
8.3.2.2.2 A connection between the one or more equipment grounding conductor and a metal box by means of a grounding screw (which shall be used for no other purpose) or a listed grounding device.
8.3.2.2.3 The equipment grounding conductor shall be permitted to be secured under a screw threaded into the fixture canopy other than a mounting screw or cover screw or attached to a listed grounding means (plate) in a non-metallic outlet box for fixture mounting (grounding means shall also be permitted for fixture attachment screws).
8.3.2.2.4 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 which requires grounding.
8.3.2.2.5 Where more than one equipment grounding conductor or branch circuit enters a box, all such conductors shall be in good 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.
8.3.2.2.6 Cord-connected appliances shall be grounded by means of an approved cord with equipment grounding conductor and grounding attachment plug.

8.3.3 Bonding.

8.3.3.1 The neutral conductor of the power source shall be bonded to the vehicle frame.
8.3.3.2 The neutral bonding connection shall occur only at the power source.
8.3.3.3 In addition to the bonding required for the low voltage return current, each body and each driving or crew compartment enclosure shall be bonded to the vehicle frame by a copper conductor.
8.3.3.3.1 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.
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.
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 panel board.
8.3.3.3.4 A bonding conductor shall be connected between the distribution panel board 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 has been met:

(1) The metal panels overlap one another and are securely attached to the metal frame parts by metal fasteners or welding.
(2) The lower panel of the metal exterior covering is secured by metal fasteners at each cross member of the chassis, or the lower panel is bonded to the chassis by a metal strap.
8.3.3.3.6 Metal circulating air ducts shall be bonded to the chassis.
8.3.3.3.7 The compressed gas pipes (oxygen, breathing air, etc…) shall be bonded to the chassis.

8.4* Ground Fault Circuit Interrupters.
All line voltage AC circuits of the ambulance shall be protected by ground fault circuit interrupters.

8.5 Power Source General Requirements.
The requirements in 8.5.1 through 8.5.10 shall apply to all line voltage power sources.
8.5.1 All power source system mechanical and electrical components shall be sized to support the continuous duty nameplate rating of the power source.
8.5.2 The power source shall be shielded from contamination that would prevent the power source from operating within its design specifications.
8.5.3 Generators. If the power source is mechanically driven, it shall comply with Article 445, "Generators," of *NFPA 70*.

8.5.4 Power Source Rating.
8.5.4.1* For power sources of 8 kW or larger, the power source manufacturer shall declare the continuous duty rating that the power source can provide when installed on ambulance according to the manufacturer's instructions and run at 120°F (49°C) air intake temperature at 2,000 ft (600 m) above sea level.

8.5.4.2 The rating on the power source specification label shall not exceed the declared rating from the power source manufacturer.
8.5.5 Access shall be provided to permit both routine maintenance and removal of the power source for major servicing.
8.5.6 The power source shall be located such that neither it nor its mounting brackets interfere with the routine maintenance of the ambulance.

8.5.7 Instrumentation.

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

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

8.5.7.3* If the power source is rated at 8 kW or more, the following instrumentation shall be provided at an operator's panel:
(1) Voltmeter
(2) Current meters for each ungrounded leg
(3) Frequency (Hz) meter
(4) Power source hourmeter

8.5.7.4 The instrumentation shall be permanently mounted at an operator's panel.
8.5.7.4.1 The instruments shall be located in a plane facing the operator.
8.5.7.4.2 Gauges, switches, or other instruments on this panel shall each have a label to indicate their function.
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.

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.

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 position as designated by the purchaser.

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.

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.

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.

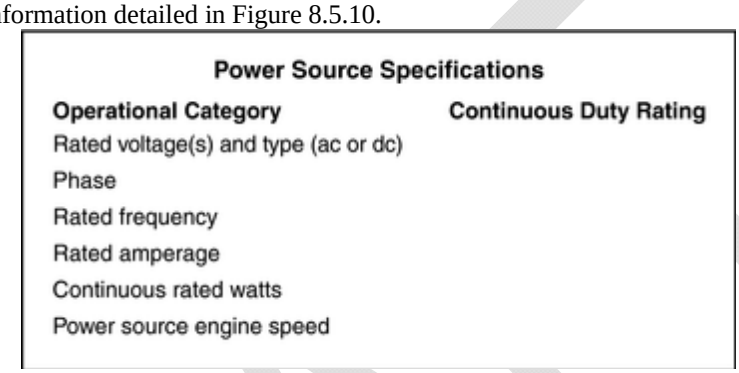


FIGURE 8.5.10 Power Source Specifications Label.

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 drive shaft 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.

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.

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.

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.

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.

8.6.2.3 Hydraulic Components.

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

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

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

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

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

8.6.3.1 The generator shall be installed so that fumes, vapors, heat, and vibrations do not enter the driving or patient compartment.
8.6.3.2* Generators rated at 8 kW or more shall be equipped with a high temperature automatic shutdown system and a low oil (pressure or level) automatic shutdown system.

8.6.3.3 The generator shall be installed in accordance with the generator manufacturer's requirements for ventilation and service accessibility.
8.6.3.4 If the generator is installed in a compartment and the compartment doors shall be open during its operation, the generator shall be equipped with an interlock system to prevent its operation if the doors are not open, or the compartment shall be equipped with a high temperature alarm.
8.6.3.5 If the generator is installed in a compartment on a slide tray and the slide tray shall be in the extended or out position during operation, an interlock shall be provided to prevent operation unless the tray is in the correct position, or the compartment shall be equipped with a high temperature alarm.
8.6.3.6 Permanently installed generators shall have readily accessible engine oil drain provisions or piping to a remote location for oil changing.
8.6.3.7 If the generator is 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.

8.6.3.8 Fuel System.

8.6.3.8.1 Fuel lines shall be protected from chafing at all wear points.
8.6.3.8.2 If the fuel source is shared with the ambulance engine, a separate fuel pickup system shall be provided that is arranged to ensure that the generator cannot utilize more than 75 percent of the fuel tank's capacity.

8.6.3.9 Exhaust System.

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

8.6.3.9.2 The exhaust shall be piped to the exterior of the vehicle and discharged at a location away from any operator's position.
8.6.3.9.2.1 The exhaust system for the generator shall comply with Section 5.6.
8.6.3.9.3 Where parts of the exhaust system are exposed so that they can cause injury to operating personnel, protective guards shall be provided.
8.6.3.9.4 Silencing devices shall be provided and shall not create exhaust backpressure that exceeds the limits specified by the engine manufacturer.

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

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

8.6.4.2* The alternator and/or battery system shall be adequate to provide power for continuous operation for a

minimum of 2 hours at full output.

8.6.5 Power Sources Requiring Elevated Engine Speed. If the power source requires the chassis engine to be operating at a specific fixed speed or a specific speed range, it shall meet the requirements of 8.6.5.1 through 8.6.5.3.
8.6.5.1 The main propulsion engine shall have a governor capable of maintaining the engine speed within the limits required by the power source to meet the frequency control, voltage control, and power output specifications.
8.6.5.2 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.
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.

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*.

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

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

8.7.3 Wiring for Portable Generator Installations. Wiring installed for the purpose of facilitating the distribution of power from a portable generator installation to fixed wiring on the ambulance shall conform to the additional requirements of 8.7.3.1 through 8.7.3.5.
8.7.3.1 Circuit conductors shall be sized in relation to the power source specification label rating and shall be protected by an overcurrent device commensurate with their amperage capacities.
8.7.3.2 There shall be a single output connector cord with all of the conductors in the cord sized to carry a minimum of 115 percent of the nameplate amperage.
8.7.3.3 If there is not an overcurrent protection device at the power source, the output connector cord shall not exceed 72 in. (1830 mm) in length and shall be connected to an overcurrent protection device.
8.7.3.4 The rating of an external main overcurrent protection device shall equal the rated amperage on the power source specification label or the next larger available size overcurrent protection device where so recommended by the power source manufacturer.
8.7.3.5 If a connecting plug is required, it shall be sized in relation to the system and conform to NEMA configurations for plugs.

8.8 Transfer Switch Applications.

8.8.1 A transfer switch shall be required to isolate one power source from the other where a circuit(s) is intended to be supplied from more than one power source.
8.8.2 Transfer equipment, including transfer switches, shall operate such that all ungrounded conductors of one power source are disconnected before any ungrounded conductors of the second power source are connected.
8.8.3 The neutral conductor shall be switched through the transfer switch.

8.9 Power Supply Assembly.

8.9.1 The conductors used in the power supply assembly between the output terminals of the power source and the

main overcurrent protection device shall not exceed 12 ft (4 m) in length.

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

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

8.10 Overcurrent Protection.
Manually resettable overcurrent devices shall be installed to protect the line voltage electrical system components.
8.10.1 Power Source Protection. A main overcurrent protection device shall be provided that is either incorporated in the power source or connected to the power source by a power supply assembly.
8.10.1.1 The size of the main overcurrent protection device shall not exceed 100 percent of the rated amperage stated on the power source specification label or the rating of the next larger available size overcurrent protection device, where so recommended by the power source manufacturer.
8.10.1.2 If the main overcurrent protection device is subject to road spray, the unit shall be housed in a Type 4–rated enclosure.

8.10.2 Branch Circuit Overcurrent Protection. Overcurrent protection devices shall be provided for each individual circuit and shall be sized at not less than 15 amps in accordance with 240.4, "Protection of Conductors," of *NFPA 70*.
8.10.2.1 Any panelboard shall have a main breaker where the panel has six or more individual branch circuits or the power source is rated 8 kW or larger.
8.10.2.2 Each overcurrent protection device shall be marked with a label to identify the function of the circuit it protects.
8.10.2.3 Dedicated circuits shall be provided for any large appliance or device (air conditioning units, large motors, etc.) that requires 60 percent or more of the rated capacity of the circuit to which it is connected, and that circuit shall serve no other purpose.

8.10.3 Panelboards. All fixed power sources shall be hardwired to a permanently mounted panelboard unless one of the following conditions exists:
(1) All line voltage power connections are made through receptacles on the power source and the receptacles are protected by integrated overcurrent devices.
(2) Only one circuit is hardwired to the power source, which is protected by an integrated overcurrent device.
8.10.3.1 The panel shall be visible and located so that there is unimpeded access to the panelboard controls.
8.10.3.2 All panelboards shall be designed for use in their intended location.
8.10.3.3 The panel(s) shall be protected from mechanical damage, tool mounting, and equipment storage.
8.10.3.4* Where the power source is 120/240 V and 120 V 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 V and at temperatures not less than 194°F (90°C)

8.11.1 Electrical cord or conduit shall not be attached to chassis suspension components, water or fuel lines, air or air brake lines, oxygen lines, hydraulic lines, exhaust system components, or low voltage wiring and shall be arranged as follows:
(1) Separated by a minimum distance of 12 in. (300 mm) from exhaust piping or shielded from such piping
(2) Separated from fuel lines by a minimum distance of 6 in. (152 mm)

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

8.11.2 A means shall be provided to allow "flexing" between the driving and crew compartment, the body, and other areas or equipment whose movement would stress the wiring.
8.11.3 Electrical cord or conduit shall be supported within 6 in. (152 mm) of any junction box and at a minimum of every 24 in. (600 mm) of run.
8.11.3.1 Supports shall be made of nonmetallic materials or of corrosion-resistant or corrosion-protected metal.
8.11.3.2 All supports shall be of a design that does not cut or abrade the conduit or cord and shall be mechanically fastened to the ambulance
8.11.4 Only fittings and components listed for the type of cord or conduit being installed shall be used.
8.11.4.1 Where rigid metal conduit or intermediate metal conduit is terminated at an enclosure with a lock nut and bushing connection; two lock nuts shall be provided, one inside and one outside of the enclosure.
8.11.4.2 All cut ends of conduit shall be reamed or otherwise finished to remove rough edges.
8.11.5 Splices shall be made only in a listed junction box.

8.11.6 Additional Requirements for Flexible Cord Installations.
8.11.6.1* Where flexible cord is used in any location where it could be damaged, it shall be protected by installation in conduit, enclosures, or guards.

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

8.11.7 Wiring Identification.

8.11.7.1 Each line voltage circuit originating from the main panelboard shall be identified.
8.11.7.2 The wire or circuit identification either shall reference a wiring diagram or wire list or shall indicate the final termination point of the circuit.
8.11.7.3 Where pre-wiring for future power sources or devices exists, the un-terminated ends shall be marked with a label showing their wire size.
8.12 Wiring System Components.

8.12.1 Only stranded copper conductors with an insulation rated for temperatures of at least 194°F (90°C) and wet locations shall be used.
8.12.1.1 Conductors in flexible cord shall be sized in accordance with Table 400.5(A) of *NFPA 70*.
8.12.1.2 Conductors used in conduit shall be sized in accordance with 310.15, "Ampacities for Conductors Rated 0–2000 Volts," of *NFPA 70*.
8.12.1.3 Aluminum or copper-clad aluminum conductors shall not be used.
8.12.2 All boxes shall conform to and be mounted in accordance with Article 314, "Outlet, Device, Pull, and Junction Boxes; Conduit Bodies; Fittings; and Manholes," of *NFPA 70*.
8.12.2.1 All boxes shall be readily accessible.
8.12.2.2 Boxes shall not be permitted behind welded or pop-riveted panels.
8.12.2.3 The maximum number of conductors permitted in any box shall be in accordance with 314.16, "Number of Conductors in Outlet, Device, and Junction Boxes, and Conduit Bodies," of *NFPA 70*.
8.12.3* All wiring connections and terminations shall provide a positive mechanical and electrical connection.

8.12.3.1 Connectors shall be installed in accordance with the manufacturer's instructions.
8.12.3.2 Wire nuts or insulation displacement and insulation-piercing connectors shall not be used.

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

8.12.4.1 All switches shall be marked with a label indicating the function of the switch.
8.12.4.2* Circuit breakers used as switches shall be "switch rated" (SWD) or better.
8.12.4.3 Switches shall simultaneously open all associated line voltage conductors.
8.12.4.4 Switching of the neutral conductor alone shall not be permitted.
8.12.4.5 Line voltage circuits controlled by low voltage circuits shall be wired through properly rated relays in listed enclosures that control all nongrounded current-carrying conductors.

8.12.5* Receptacles and Inlet Devices.

8.12.5.1 The patient compartment shall be furnished with a minimum of three (3) line voltage duplex receptacles conforming to NEMA 5-15.
8.12.5.2 Receptacles shall be near flush, vertically mounted.
8.12.5.3 All interior outlets shall be installed in accordance with Section 210-7 (Receptacles and Cord Conductors) of the NEC.
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 Section 406.8, "Receptacles in Damp or Wet Locations," of *NFPA 70*.
8.12.5.6.2 All receptacles located in a wet location shall be not less than 24 in. (600 mm) from the ground.
8.12.5.6.3* Receptacles on off-road ambulances shall be a minimum of 30 in. (760 mm) from the ground.
8.12.5.7 All receptacles located in a dry location shall be of the grounding type and shall be at least 12 in. (300 mm) above the interior floor height.
8.12.5.8 No receptacle shall be installed in a face-up position.
8.12.5.9 The face of any wet location receptacle shall be installed in a plane from vertical to not more than 45 degrees off vertical.

8.12.5.10 Receptacle Label.
8.12.5.10.1 Each receptacle shall be marked with a label indicating the nominal line voltage (120 volts or 240 volts) and the current rating in amps of the circuit.
8.12.5.10.2 If the receptacle is DC or other than single phase, that information shall also be marked on the label.
8.12.5.11* All receptacles and electrical inlet devices shall be listed to UL 498, *Standard for Safety Attachment Plugs and Receptacles*, or other recognized performance standards.
8.12.5.12 Receptacles used for DC voltages shall be rated for DC service.
8.13 Cord Reels.
8.13.1 All permanently mounted cord reels shall be rated for continuous duty and installed to be accessible for removal, cord access, maintenance, and servicing.
8.13.2 The power rewind cord reel spool area shall be visible to the operator during the rewind operation, or the reel spool shall be encapsulated to prevent cord from spooling off the reel.
8.13.3 Rollers or guides shall be provided, where required, to prevent damage to the cord at reel spools or compartment openings.
8.13.4 Rewind Provision.
8.13.4.1 Manually operated reels shall have a hand crank.
8.13.4.2 Power rewind–type reels shall have the control in a position where the operator can observe the rewinding operation.
8.13.4.3 If a reel is in an enclosure or out of direct view, the cord entry point to the enclosure shall be visible to the operator of the reel control.
8.13.4.4 The rewind control or crank shall not be more than 72 in. (1830 mm) above the operator's standing position.
8.13.4.5 The rewind control shall be marked with a label indicating its function and shall be guarded to prevent accidental operation.
8.13.5* The reel shall be designed to hold 110 percent of the capacity needed for the intended cord length.

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

8.13.7* Electrical cord shall be Type SEOOW, Type SOOW, or Type STOOW.

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

(1) Current rating
(2) Current type
(3) Phase
(4) Voltage
(5) Total cord length

8.13.9 Where a power distribution box is hardwired to the end of a cord that is stored on a fixed cord reel or other fixed storage means, the requirements in 8.13.9.1 through 8.13.9.6 shall apply.

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

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

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

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

8.13.9.5* Remote power distribution boxes shall have a light on the box to indicate the power is on.

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.

8.13.9.5.2 The light shall be mechanically protected to prevent damage.

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

8.14 Scene Lighting Systems.

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

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

8.14.3 Handle on Lights.

8.14.3.1 If the light is adjustable, a handle shall be provided.

8.14.3.2 The design of the light shall not allow the temperature of the handle to exceed 131°F (55°C).

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

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

8.15 Appliance Accessibility and Fastening.

8.15.1 All electrical appliances shall be accessible for inspection, service, repair, and replacement without removal of permanent construction.

8.15.2 Appliances shall be fastened in accordance with the manufacturer's directions.

Chapter 9 Test Methods

9.1 Low Voltage Electrical System Test.

9.1.1* The ambulance 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.

9.1.2 Test Sequence.

9.1.2.1 The three tests defined in 9.1.2.2 through 9.1.2.4.4 shall be performed in the order in which they appear.

9.1.2.1.1 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.

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

9.1.2.2 Reserve Capacity Test.

9.1.2.2.1 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.

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

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

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

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

9.1.2.3 Alternator Performance Test at Idle.

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

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

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

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

9.1.2.4 Alternator Performance Test at Full Load.

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

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

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

9.1.2.4.4 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 V dc for a 12 V nominal system, 23.6 V dc for a 24 V nominal system, or 35.4 V dc for a 42 V nominal system for more than 120 seconds shall be considered a test failure.

9.1.3 Low Voltage Alarm Test.

9.1.3.1 The following test shall be started with the engine off and the battery voltage at or above 12 V for a 12 V nominal system, 24 V for a 24 V nominal system, or 36 V for a 42 V nominal system.

9.1.3.2 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.

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

9.1.3.4 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 V for a 12 V nominal system, 23.4 V dc for a 24 V nominal system, or 35.1 V for a 42 V nominal system.

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

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

9.2* Line Voltage Electrical Systems Test.

9.2.1 The wiring and associated equipment shall be tested by the ambulance manufacturer or the installer of the line voltage system.

9.2.3* The electrical polarity of all permanently wired equipment, cord reels, and receptacles shall be tested to verify that wiring connections have been properly made.

9.2.4 Electrical continuity shall be verified from the chassis or body to all line voltage electrical enclosures, light housings, motor housings, light poles, switch boxes, and receptacle ground connections that are accessible to personnel in normal operations.

9.2.5 If the ambulance is equipped with a transfer switch, it shall be tested to verify operation and that all nongrounded conductors are switched.

9.2.6 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.

9.2.7* Certification Test of Power Source.

9.2.7.1 The ambulance manufacturer or installer of the power source shall perform a certification test on each power source.

9.2.7.2 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.

9.2.7.3 Test Procedure.

9.2.7.3.1 The prime mover shall be started from a cold start condition, and the unloaded voltage and frequency shall be recorded.

9.2.7.3.2 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. Testing with a resistive load bank shall be permitted.

9.2.7.3.3 The power source shall be operated in the manner specified by the ambulance manufacturer as documented on instruction plates or in operation manuals.

9.2.7.3.4 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.

9.2.7.3.4.1 The load shall be adjusted to maintain the output wattage at or above the continuous rated wattage during the entire 2-hour test.

9.2.7.3.4.2 The following conditions shall be recorded at least every ½ hour during the test:

(1) The power source output voltage, frequency, and amperes
(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

9.2.7.3.4.3 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

9.2.7.3.5 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.

9.2.7.3.6 The load shall be removed, and the unloaded voltage and frequency shall be recorded.

9.2.7.3.7 Voltage shall be maintained within ±10 percent of the voltage stated on the power source specification label during the entire test.

9.2.7.3.8 Frequency shall be maintained within ±3 Hz of the frequency stated on the power source specification label during the entire test.

Annex A Explanatory Material

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

A.1.4 It is not intended that this standard be applied retroactively to existing ambulances. However, if major renovations are made to an existing ambulance, it is suggested that the ambulance be brought into line with this standard as closely as possible.

A.1.6 Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). The liter, a unit that is outside of but recognized by SI, is commonly used in international fire protection. Table A.1.6(a) and Table A.1.6(b) provide U.S.-to-SI conversion factors and SI-to-U.S. conversion factors as an aid to the user. Table A.1.6(c) provides other conversion factors that could be useful to the reader. Table A.1.6(d) provides a list of the abbreviations used in this standard and their meanings.

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

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

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

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

Table A.1.6(c) Other Useful Conversion Factors

1 gallon per minute (gpm)	=	).833 imperial gallon per minute (igpm)

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

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

Abbreviation	Term
ac	alternating current
C	Celsius
cd	candela(s)
dc	direct current
EM SP	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/m	liter(s) per minute
in	
lx	lux
m	meter(s)
mm	millimeter(s)
mph	mile(s) per hour
NH	National Hose
psi	pound(s) per square inch
rms	root mean square
V	volt(s)

A.2.3.17 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.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do

their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

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.

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.

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

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

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

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

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

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.

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

Turning Clearance Radius. An aerial fire apparatus might have a larger overall clearance diameter if measured at the forwardmost point of the aerial device.

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.4.11.1 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 ambulance. 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.4.12.3 The interior of the ambulance patient compartment should be maintained at a minimum temperature of 50°F (10°C)when the ambulance is prepared for immediate response. The purchaser should consider how this will be accomplished. If the ambulance will not be housed in a heated facility, then other means may be required to ensure that this requirement is met. This requirement does not apply to ambulances that are fully operational but being held in reserve or ambulances that are not fully operational.

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

A.4.13.4 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 off-road capability.

A.4.16 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.4.16.2 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.4.17.2.3 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.4.17.3.1 The label shown in Figure 4.17.3.1 is a suggested format. Deviations in dimensions are acceptable.

A.4.17.4.1 The form shown in Figure 4.17.4.1 is a suggested format. Deviations in dimensions are acceptable.

A.5.1.4.2 It is important for apparatus drivers to understand the height, length, and weight of the vehicle compared to their personally owned vehicles. It is also important that this information be accurate. Because the height of the apparatus could change after delivery, depending on what equipment might be added, the department must note such changes on the plate. Suggested wording for the plate is shown in Figure A.5.1.4.2.

PLEASE ADD FIGURE FROM 1906 DRAFT 1906:A.5.1.5.1

A.5.2 Weight Distribution Measurement and Calculation Methods Payload Determination

Subtract the total curb weight of the completed vehicle from the GVWR. Any permanently attached, optional items of equipment specified by the customer are to be included in the curb weight of the completed vehicle. Any other items of optional equipment (i.e., not permanently attached and/or removable) are to be included in the payload requirement.

A.5.2.2 The projections of total equipment payload and mounting locations are essential for proper engineering of a new ambulance. The purchaser of the ambulance should maintain the side-to-side loading requirement in 5.2.2 as equipment is loaded or installed on the ambulance.

The percentage difference in side-to-side tire load should be calculated as shown in the following formula:

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

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 with a GVWR less than 36,000 lb (16,300 kg) 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 apparatus is operated on slippery surfaces. Follow the auxiliary braking device manufacturer's recommendations for proper instructions.

A.5.8.1 The angle of approach or departure affects the road clearance of the vehicle going over short steep grades such as would be found in a driveway entrance, crossing a high crowned road at a right angle, or off-road service. Too low an angle of approach or departure will result in the vehicle scraping the ground. Figure A.5.8.1 shows the method of determining the angle of departure. The angle of approach (front of vehicle) is measured in the same fashion.

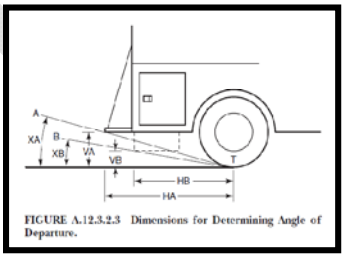


FIGURE A.12.3.2.3 Dimensions for Determining Angle of Departure.

STAFF – Please Use this Figure from NFPA 1901 but delete the diagonal line that extends from the rear bumper up to the body. This will be a fine representation of an ambulance.

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, 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. Determine the lowest point (the bumper, fuel tank, or other equipment or component) that would make the smallest angle of departure. Hang a plumb bob from the lowest point and mark the point on the ground where the point of the plumb bob touches. Measure the vertical distance from the ground to the point where the plumb bob was hung (distance V). 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). 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 may include positive locking differential, limited slip differential, electronic traction control, etc…

A.5.9.6 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. While the design and features of the vehicle are important to safe driving, the most important aspect of crash prevention is the skill and experience of the operator. The operator's attitude, training, experience, qualifications, and the application of those qualities are the most important elements in crash prevention. The operator must ensure that the physical limits of the vehicle are not exceeded. Driver skill is developed only through training and practice.

A.5.11.1 The purchaser may wish 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.5.14 Purchasers may wish to consider specifying that all mirror head faces be independently adjustable from the driver's position when this feature is available from the OEM.

A.6.11.5 The intent of step size and placement requirements is to ensure that the foot is supported when it is placed on the step in the normal climbing position. In some cases the most natural method of mounting a step may not be perpendicular to the leading edge (common on chassis where it would be natural not to open the door completely to the 90 degree point and enter the door opening at a diagonal from the rear). In these cases the clearance measurement can be taken diagonally across the step in the natural direction of climb.

A.6.17 MEASURING GUIDELINES: CABINETS & COMPARTMENTS [Consider making this a separate annex. The amount of info and level of detail would be best suited as an annex]

Cabinet Depth: The dimension from the cabinet inside back wall to the outside cabinet face.

Compartment Depth: The dimension from the compartment inside back wall to the outside compartment face.

Door OD: The door overall outside thickness (dimension).

Depth ID: The actual interior depth ether measured or figured by subtracting the Door OD from the cabinet or compartment measured depth.

Height ID: The dimension from the interior bottom surface to the interior surface of the cabinet or compartment top.

Width ID: The dimension from one interior surface to the next interior surface of the cabinet or compartment.

Sliding Window Track: The track used for sliding cabinet windows.

Sliding Cabinet Windows: The sliding doors used on interior cabinets.

Interior cabinet with sliding doors or roll-up doors (Figure 1).

a. Measuring from the back of the rear wall to the back of the sliding window track, record that dimension for Depth ID.

b. Measuring from cabinet interior wall to wall, record that dimension for Width ID.

c. Measuring from the interior top to bottom, record dimension. This is the Height ID.

d. Multiply Height ID x Width ID x Depth ID = then divide by 1,728 to get cubic feet.

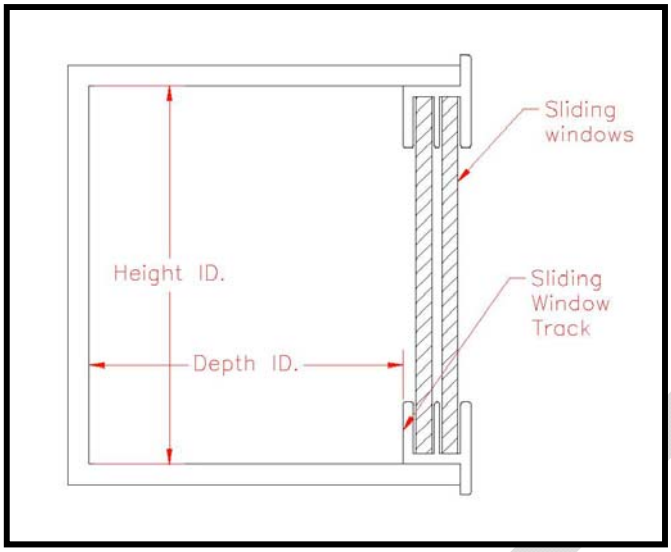


Figure 1

Interior cabinets with hinged doors (Figure 2).

a. Measure from the back of the door to the face of the door and record that dimension for Door OD.

b. Measure from the back of the rear wall to the cabinet face and record that dimension for cabinet depth.

c. Subtract the Door OD from the cabinet depth to get Depth ID.

d. Measure from cabinet interior wall to wall and record that dimension for Width ID.

e. Measure from the interior top to bottom and record dimension. This is the Height ID.

f. Multiply Height ID x Width ID x Depth ID = then divide by 1,728 to get cubic feet.

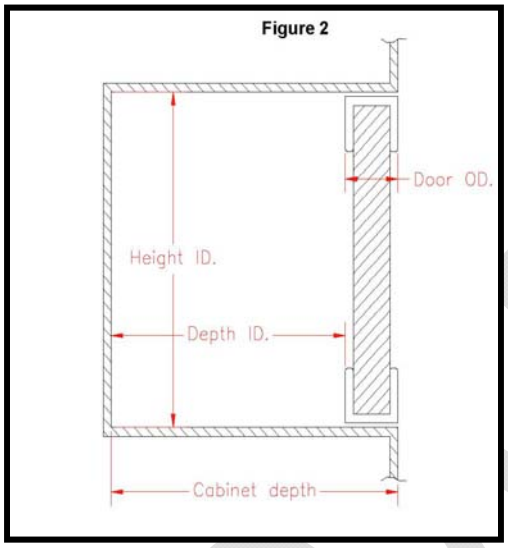


Figure 2

Exterior Compartments with hinged doors (Figure 3).

a. Measure from the back of the door to the face of the door and record that dimension for Door OD.

b. Measure from the back of the rear wall to the cabinet face and record that dimension for cabinet depth.

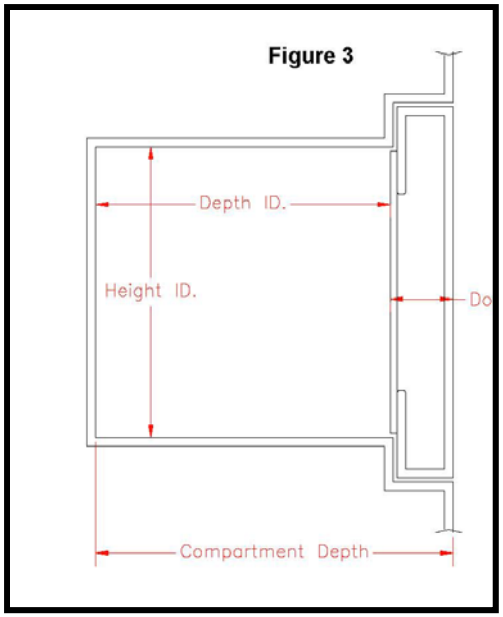
c. Subtract the Door OD from the cabinet depth to get Depth ID.

d. Measure from cabinet interior wall to wall and record that dimension for Width ID.

e. Measure from the interior top to bottom and record dimension this is the Height ID.

f. Multiply Height ID x Width ID x Depth ID = then divide by 1,728 to get cubic feet.

NOTE: Subtract any notches for spring shackles or fuel systems from the total to get the correct total cubic feet.



A.6.24.2 It is not recommended that SCBA packs be stored in the patient compartment because of the risk of contamination. If the purchaser does specify SCBA storage in seat backs, then they should meet the requirements found in NFPA 1901.

A.6.24.3.1 Purchasers may wish to consider specifying seat belt colors such as bright red or bright orange. Bright belt colors are easier to see on drive-cam videos or by observation through the window when enforcing seat belt use compliance.

FMVSS 210 S4.3.1.1 requires that the lap portion of the belt in any Designated Seating Position does not constrain the occupant high across the belly.

FMVSS 210-S5.1 requires that seat belt anchorages for side facing seatbelt assembly shall withstand a minimum of 1134 kg (2,500 lbs.) force.

A.6.29 The purchaser should specify whether the striping required under this standard will be provided by the manufacturer on delivery of the apparatus or will be installed by the purchaser or its designee following delivery. In any event, the required striping must be installed before the unit is placed in emergency service.

A.6.29.1 If the purchaser specifies exterior doors, consideration should be given to affixing the stripe of reflective material in a location that will not be obscured or lost when the doors are open.

A.7.1 This chapter defines the requirements for alternators, batteries, load management, and instrumentation to detect incipient electrical system failure. The intent is to require an electrical system that will operate the ambulance using power supplied by the alternator, shed nonessential electrical loads where necessary, and provide early warning of electrical failure in time to permit corrective action.

A.7.2.1.1 The 125 percent requirement for wiring and circuits is intended to provide reduced voltage drop over wire rated based on ampacity due to heating. In low voltage wiring, voltage drop becomes a problem before the thermal limit of current carrying capacity of a wire is reached. This requirement also ensures that the circuit protection will prevent damage to the wire in the event of a short or an overload. It is not the intent of this requirement to have the final-stage manufacturer replace the chassis manufacturer's original equipment wiring to meet the 125 percent requirement. It is also not the intent of this requirement to have electrical accessories purchased by the ambulance manufacturer rewired to meet the 125 percent requirement. Electrical device manufacturer–supplied wiring can be used to the point where it connects to the ambulance manufacturer's installed wiring.

A.7.2.2.9 It is the intent of 7.2.2.9 to provide a unique means of identifying a wire or circuit to prevent confusing it with another wire or circuit if electrical system repairs become necessary. If a color coding

scheme is used instead of some other unique identification, that color should not be reused for a wire in any unrelated circuits within the same harness. However, 7.2.2.9 covers low voltage wiring only and does not apply to shielded cables commonly used for communication purposes or wiring used in line voltage circuits.

A.7.3.2 The minimum alternator size is developed using the loads required to meet the minimum continuous electrical load. Most ambulance will actually have loads exceeding the minimum requirements of this standard. The purchaser should review the maximum current output of the alternator versus the load study supplied for the ambulance from the manufacturer for on-scene and responding modes.

A.7.4.1(10) The purchaser should analyze the electrical loads that need to be maintained to fulfill the mission of the ambulance and define those loads for the manufacturer of the ambulance. The purchaser needs to understand, however, that there is a limit to the output capacity of an alternator system on the ambulance's engine and that this standard requires that the ambulance be capable of maintaining the minimum continuous electrical load under the conditions defined in 7.3.2. When that load is exceeded and larger alternators are not available, the purchaser and the manufacturer need to work together to determine how to reduce the minimum continuous electrical load to that which can be sustained under the conditions defined in 7.3.2.

A.7.4.3 The unexpected shutdown of an ambulance during a response can place patients in mortal danger and seriously affect the life saving ability of the crew. With computer-controlled engines and transmissions as well as other controls, an electrical system failure could result in an immediate and total shutdown of the ambulance. The low voltage monitoring system is intended to provide an early warning of an impending electrical failure and provide enough time to permit operator intervention.

A.7.5.1 Electrical loads on ambulances frequently exceed the alternator capacity. Exceeding alternator capacity will result in the deep discharge of the ambulance batteries. Automatic load management is intended to protect the batteries and electrical system from needless damage while maintaining the operation of essential devices.

It is important that the priority of all managed loads be specified by the purchaser so that, as electrical loads are disconnected from the ambulance's electrical systems, they are shed in an order least likely to affect emergency operations. Optical warning devices in excess of the minimum required in this standard can and should be load managed.

A.7.6 Batteries usually have two ratings: "cold cranking amperes," which determine the size engine that can be started, and "reserve capacity," which provides a measure of the total power that can be provided at a much lower constant rate of discharge. Ambulance batteries should be sized to have enough cold cranking 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 be plugged only into a receptacle protected by a ground-fault circuit interrupter (GFCI) at the shoreline origination point.

A.7.6.7. The purchaser might want to add an illuminated "Module Disconnect" switch which could control all electrical loads for the module. The illuminated switch could control a solenoid. If the switch is specified it should be located in the driver's compartment, be legibly marked, illuminated when "ON," and rated to carry at least 125 percent of the circuit's maximum current, unless it operates a solenoid. If the switch operates a solenoid then the solenoid should be rated for 125 percent of the circuit's maximum current. The module disconnect switch or device shall be different in feel from other switches, or be physically isolated from them.

A.7.8 SAE J551/1 provides test procedures and recommended levels to assist engineers in the control of broadband electromagnetic radiation and in the control of radio interference 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 apparatus. If compliance certification is required, it should be so indicated in the ambulance specifications.

A.7.9.1 The upper-level optical warning devices provide warning at a distance from the ambulance and the lower-level optical warning devices provide warning in close proximity to the apparatus. *(See Figure A.7.9.1.)*

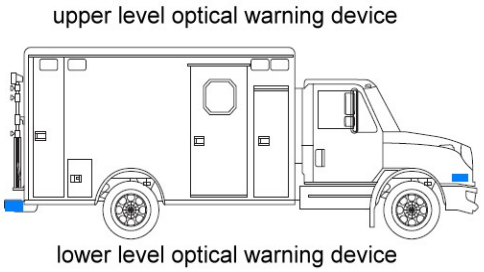


FIGURE A.7.9.1 Upper- and Lower-Level Optical Warning Devices.

We need to change this figure to an ambulance

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 levels of warning when the ambulance driver believes such reductions are appropriate, given the vehicle's mission, the weather, or other operational factors. Additional switches downstream of the master switch can be specified by the purchaser to control individual devices or groups of devices.

Purchasers might want to specify traffic flow–type lighting such as amber directional indicators for use in alerting approaching motorists of blocked or partially blocked highways.

A.7.9.10 When a component such as a flasher or power supply is used to operate more than one optical source, the optical sources should be connected so that the failure of this component does not create a measurement point without a warning signal at any point in any zone on either the upper or lower level. Although a single optical source can be used to provide warning signals into more than one zone, the possibility of 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 to the front of the ambulance. Daylight flashing of the high beam filaments is very effective and is generally considered safe. Nighttime flashing could affect the vision of oncoming drivers as well as make driving the ambulance more difficult.

In some jurisdictions, headlight flashing is prohibited or limited to certain types of emergency vehicles. If flashing headlights are employed on ambulance, they are to be turned off when the ambulance headlights are on. They should also be turned off along with all other white warning lights when the apparatus is in the blocking mode.

Steady burning headlights are not considered warning lights and can be illuminated in the blocking mode to light the area in front of the ambulance. Consideration should be given, however, to avoid shining lights into the eyes of oncoming drivers.

A.7.9.13 The minimum optical warning system should require no more than an average of 40 A for the operation of the upper-level and lower-level devices in the blocking mode. On ambulance whose length requires midship lights, no more than 5 A of additional current should be required for the operation of each set of midship lights. Optical warning systems drawing more than 40 A 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 fire apparatus.

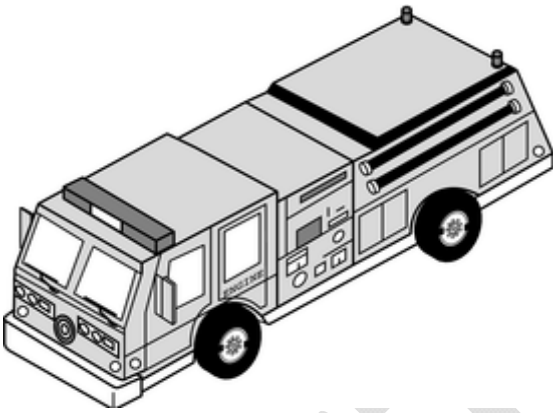


FIGURE A.7.9.13(a) Front and Left Side of an Apparatus with an Optical Warning System.

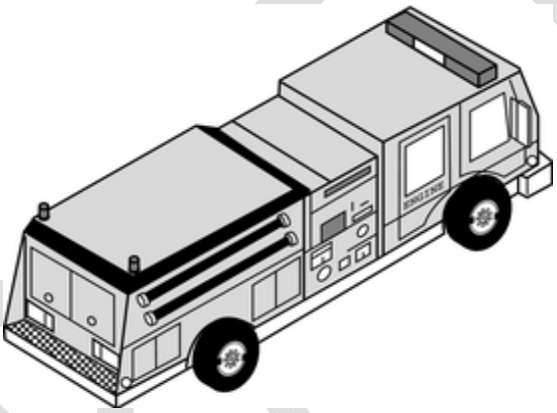


FIGURE A.7.9.13(b) Rear and Right Side of an Apparatus with an Optical Warning System.

Larry please change diagrams to ambulances

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.

The engineering basis of Section 7.9 permits both the design and the certification of an optical warning system by mathematical combination of the individual test reports for any number of optical warning devices of different color, flash rate, optical source, and manufacturer.

Using the test reports provided by the device manufacturer, the contribution of optical energy from each optical source is determined for every data point. The total candela-seconds per minute of optical energy is determined at each point, and then the zone totals are calculated and compared to Table 7.9.13.5.

A.7.9.14 The minimum optical warning system should require no more than an average of 35 A for the operation of the devices in the blocking mode.

A.7.9.16 In a few cases, a manufacturer might wish to type certify 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 either mounted on the ambulance or on a frame duplicating the mounting of the device on the ambulance. The performance of the system can be directly measured along the perimeter of a circle with a 100 ft (30.5 m) radius from the geometric center of the ambulance. Each optical warning device used should be certified by its manufacturer as conforming to all the requirements of this standard pertaining to mechanical and environmental testing. 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 wishes 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 ambulance's, 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 may want to consider a map light or additional task lighting in the cab

A.7.1.6.3 The purchaser might want to add "checkout lights" which may be controlled by a timer or switch wired directly to the batteries. These "checkout" lights are usually fluorescent lights wired to the line voltage shoreline and may be wired so that the ambulance ignition or battery switch need not be turned on.

A.7.11.6.2.4 .2 The purchaser should consider light color temperatures when specifying interior lighting. Different temperature lights could effect the operation and diagnoses of patients. A temperature closer to daylight would give the best results, but might not be feasible with the available lights. A good range seems to be between 2500 and 4500 Kelvin, see Figure A.7.11.6.2.4.2 below.

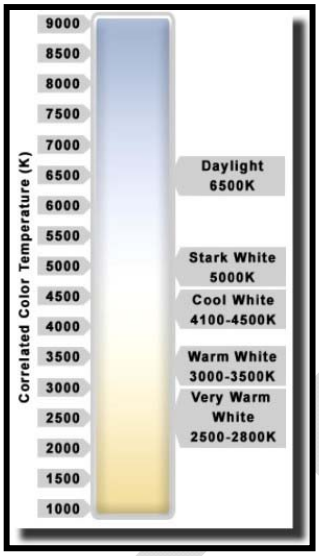


Figure A.7.11.6.2.4.2 Light Color Tempurature Scale.

A7.12.1 Electronic displays that are visible in all ambient light, that projects narrative information may be used in lieu of discrete, colored, indicator/ warning lights provided the projected message is at least as visible as the basic required warning light.

A.7.13 The purchaser might wish to add camera(s) at the sides or rear of a vehicle with cab monitoring screens or automatic vehicle-stopping devices that sense an obstruction at the rear of the vehicle. In addition, angled backup lights mounted in the wheel well areas will provide additional scene lighting for personnel who might be at the side of the vehicle or lighting of folding tanks or other obstacles on the side of the ambulance. Any such devices will improve safety while vehicles are backing.

A 7.15.2 The purchaser should specify the appropriate features to accommodate their communication equipment, including but not limited to metal ground planes, grounding, coaxial cable and antenna placement

A.8.2.2.1 The purchaser should specify the location on the apparatus for the power Inlet. Consideration should be given to placement of the power inlet so that it disconnects if the apparatus is moved forward or an auto-eject device may be utilized. The shoreline and circuit breaker should be sized for the anticipated electrical load.

A.8.2.5.3 Portable line voltage electrical equipment added by the ambulance service should also be listed and utilized only in accordance with the manufacturer's instructions.

A.8.2.6.4 Although a splash shield will lessen the amount of road spray that reaches the generator, it will not protect the generator if the ambulance is driven through deep water. Care should also be taken if the ambulance is driven off-road, because a splash shield is not a skid pan and will not protect the generator from physical abuse.

A.8.3.1 It is important that all metal parts of the ambulance and the electrical system be bonded to the vehicle chassis. Any electrical boxes, conduits, or fixtures that are not permanently mounted to the metal body should be bonded to the protective ground wire. It is especially important that the metal light fixtures or housings of pole lights, light towers, and portable lights be grounded through the protective ground wire. *NFPA 70, National Electrical Code*, requires the following:

The normally non–current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are connected to the generator frame. [***70*:**250.34(A)(2), 250.34(B)(3)]

Use of a ground rod on ambulance is not recommended. If one is used, the requirements of *NFPA 70*, Article 250, should be followed. These requirements are difficult to achieve in a portable application.

Supplying a building electrical system from an ambulance is not recommended, because it commits the ambulance to the task and requires a significantly different grounding scheme, at least while being used for this application, in accordance with *NFPA 70*, 250.20, "Alternating-Current Systems to Be Grounded"; 250.30, "Grounding Separately Derived Alternating-Current Systems"; and other applicable sections of *NFPA 70*. In this situation, the grounding allowed by 250.34 is no longer applicable.

A.8.3.1.4 This refers to the protective ground (green wire), not the "neutral" wire. The ground is the chassis/body of the vehicle, not a connection to an earth ground.

A.8.4 Ground fault circuit interrupters (GFCIs) are intended to provide protection from electrical shock, but experience in the emergency services has pointed out several considerations about using them:

(1) GFCIs integrated into outlets or circuit breakers or as stand-alone devices may be used.

(2) Where possible, GFCIs should be located at the end of cords (i.e., in the distribution box at the end of a cord reel) to reduce tripping associated with long cord lengths and to put the reset function closer to the user.

(3) GFCIs might not be compatible with 120/240 volt 4-wire cord reels frequently used in emergency services unless the GFCI is located at the end of the cord.

(4) Many plugs and receptacles used in the emergency services are twist lock instead of standard nonlocking household plugs and receptacles, and in these cases, the GFCIs integrated with an outlet cannot be used, requiring circuit breaker GFCIs or standalone GFCIs.

A.8.5.4.1 The 120°F (49°C) requirement is for air inlet temperature to the power source. The completed ambulance is required to operate at an ambient temperature of 110°F (43°C). This difference of only 10°F (6°C) is difficult to achieve due to heat produced by the ambulance. The installer should take this temperature into consideration in selecting a location for the power source. If the ambulance is intended to operate at high temperatures, the purchaser may want to specify a larger nameplate rating on the generator and derate it to allow for a higher temperature capability. Consult with the power source manufacturer for more information on extended temperature range operation. In the testing required in Chapter 9.9 the ambient and air inlet temperatures are recorded, giving a measure of the temperature difference in actual operation.

The following factors could be relevant to power source testing, depending on the type of power source:

(1) *Sampling.* The selection of test unit(s) should be representative of the construction and settings for units that will be supplied to the ambulance manufacturer. The standard does not require that all production units be tested; however, the power source manufacturer should test as needed to maintain confidence in its declaration of the continuous duty rating for all production.

(2) *Clearances, cooling, and ventilation.* Testing should be conducted at the worst-case clearance (usually minimum clearance or minimum compartment size) and worst-case ventilation conditions (minimum inlet/outlet dimensions and maximum inlet/outlet restrictions) specified in the literature. If not in the literature, the power source manufacturer's declaration should indicate the clearances, compartment size, and ventilation that are applicable to the declared continuous duty rating.

(3) *Test duration.* "Continuous" ratings are usually established by tests run until thermal stabilization is achieved. A minimum test of 2 hours, matching the in ambulance test duration indicated in 9.9, is recommended.

(4) *Air inlet temperature.* Power sources should be tested in a chamber or room where the air temperature supplied to all inlet ducts (radiators, engine induction, windings, heat sinks, etc.), and the air surrounding the test unit, is maintained at 120°F (49°C).

(5) *Barometric pressure.* Pressure (air density) varies with changes in altitude and weather. Its effect is generally greatest on engines, where it affects combustion and cooling efficiency. There is a lesser effect on wound machines due to cooling only. To show compliance with the 2,000 ft (600 m) requirement, a test in a chamber simulating 2,000 ft (600 m) would be ideal, but it is not expected. Alternatively, connecting more or less than the rated load can be used to simulate/demonstrate that the

engine is capable of the power required for rated output at 2,000 ft (600 m). (Several standards organizations, such as SAE and ISO, have standards that describe how to compute load/output correction factors for barometric pressure.)

(6) *Fuel temperature.* Fuel supply for the test should be stabilized at 120°F (49°C) before testing. Increases in fuel tank temperature that can occur as a result of fuel returned to the tank should be controlled so as to provide a result that is representative of expected fuel temperature conditions for the ambulance (7) *Intake and exhaust restrictions, accessories, hydraulic pumps, and reservoirs.* Components and accessories that might reduce engine power available for electrical output or that consume electrical output from the power source should be installed and be of the type used for the model that will be ordered for ambulance use, or their effect should be separately determined and reflected in the certified output.

(8) *Break-in.* Acceptance of a reduced output rating until completion of an in-use break-in period is subject to the prior agreement of the ambulance manufacturer, who might request test evidence. When applicable, the reduced output amount and duration of the break-in period should be indicated in the power supply literature.

(9) *Voltage and frequency.* Tests should be run while maintaining the ±10 percent voltage and ±3 Hz frequency required by 8.4.2.1. Furthermore, settings for voltage and frequency should be representative of production units.

(10) *Engine speed and hydraulic flow/pressure.* The engine speed and/or hydraulic flow and pressure ranges indicated in the power source's literature should be used to verify that the declared ratings are achievable.

(11) *Hydraulic fluid temperature.* The entire hydraulic power supply system, including hydraulic fluid piping and reservoir, should be located within a test chamber where temperature is controlled to maintain 120°F (49°C). Hydraulic fluid reservoirs should be stabilized at the ambient air test temperature [120°F (49°C)] prior to the testing.

(12) *Component and material temperatures.* Although not specified in the standard, when a power supply designed for light-duty use in open air is proposed for fixed ambulance use, the power source manufacturer should evaluate the components to determine whether they will operate within their rated or design temperature limits.

A.8.5.7.3 The instrumentation should be protected from vibration, which can lead to false readings. Particular attention should be paid to reed-type frequency indicators. Digital electronic instrumentation should be selected that incorporates sample times and intervals that accurately report system performance under varying conditions

A.8.5.9 The indicator lights and interlocks specified in this section are minimums. Some manufacturers or users might choose to add additional indicator lights or interlocks.

A.8.5.9.3 Generators are operated from the side, top, front, or rear of the ambulance, and stationary operation requires that no power is applied to the wheels while operating. Therefore, it is essential that any generator system controls that shift the ambulance out of the road mode of operation to place the generator system in operation be equipped with a means to prevent dislocation of the control from its set position in the power generation mode.

A.8.6.1 A PTO generator system typically consists of a propulsion engine, a controller to regulate the propulsion engine's speed (if required), an appropriate PTO arrangement, drivetrain components, a generator, and other miscellaneous parts.

Where possible, the generator PTO system should be prevented from engaging if engine speed is above idle.

PTO gear ratios and engine governor components should be selected and matched to provide an engine speed high enough to maintain rated performance of the alternator and air conditioning system (if provided). Engine speed should be high enough to maintain rated performance of the low voltage electrical system. Continuous excessive engine speed will result in premature generator drivetrain component failure and unnecessary fuel consumption.

The purchaser should consider specifying a means to automatically disconnect the generator or reduce engine speed to idle in the event of engine overspeed.

A.8.6.2 A hydraulic generator system generally consists of a variable displacement hydraulic pump deriving its power from the propulsion engine, a controller to regulate the hydraulic fluid flow rate, a hydraulic motor driving the generator, hydraulic fluid cooler, reservoir, and other miscellaneous parts.

All hydraulic generator systems have a window of operation (speed range). When selecting the power output of the hydraulic generator system, its speed range should be compared to the operating window of the ambulance's engine and the PTO ratios available. By selecting the hydraulic generator system and PTO ratio to match the application, electrical power can be provided over a wide operating range.

The selected PTO should have a gear ratio that will allow the widest possible range of engine speeds without overspeeding the hydraulic pump.

Where possible, engagement of the generator PTO system should be prevented if engine speed is above idle.

A.8.6.2.1 The means can be a mechanical, hydraulic, or electronic device.

A.8.6.3 Engine-driven generator systems use an internal combustion engine close-coupled to a generator. Some installations are capable of producing power while the ambulance is in motion. Generators used in these applications should be specifically designed for mobile applications. Remote generator controls in the driving compartment should be considered and specified if desired

A.8.6.3.2 The purchaser should consider the following additional remote instruments where a prime mover, other than the propulsion engine, is used to drive a generator:

(1) Oil pressure gauge and low pressure indicator light and audible alarm

(2) Engine temperature gauge and high temperature indicator light and audible alarm

The purchaser might want to specify a high temperature indicator to help troubleshoot automatic shutdowns.

A. 8.6.3.9.1 Emissions from exhaust discharge pipes should be directed away from any tools or equipment, because such emissions contain an oily substance that could make the tools difficult to handle and possibly dangerous to use.

A.8.6.4 Brief descriptions of several different types of systems follow. All of these systems can overload the low voltage electrical system and cause the load management system to terminate the generation of line voltage. As a result, the amount of line voltage power that can be supplied at any given time is totally dependent on the other, higher priority demands placed on the low voltage system.

Dynamic Power Inverter. A dynamic power inverter converts alternator output power to 120 volts ac (or 120/240 volts ac). Power is electronically inverted to ac. Usually the largest system of this type is 7,500 watts. Voltage and frequency control are typically very good. These types of systems may be suited to providing electric power while the ambulance is in motion.

Static Power Inverter. A static power inverter converts 12 volt to 14 volt dc power to 120 volt ac (or 120/240 volts ac) power. Power is electronically inverted to ac. Usually the largest system of this type is 2000 watts. Voltage and frequency control are typically very good. These types of systems are suited to providing electric power while the ambulance is in motion.

Motor-Driven Generators. A motor-driven generator system converts 12 volt dc power to 120 volt ac (or 120/240 volts ac) power. The 12 volt dc motor drives an ac generator. Typical power ratings are less than 1600 watts. Voltage and frequency control are less precise than some of the other systems available. These types of systems are suited to providing electric power while the ambulance is in motion.

Transformers. Transformer systems convert energy from the alternator, which is then rectified to 120 volt dc power. Typical installations provide 1000 watts. Output voltage is directly dependent on input voltage. Input voltage is dependent on engine and alternator speed.

In most cases, other power sources that do not draw power from the low voltage system are preferable.

A.8.6.4.2 In order to provide adequate power, it may be necessary to provide a means to advance engine speed as described in 8.6.5.

A.8.6.5.3 Operations in conjunction with any other component driven off the ambulance's engine could require special or alternate interlock systems.

A.8.6.6 Devices that produce modified sine waves may be less expensive than devices that produce pure sine waves. Power from electric utilities and most traditional mechanical generators are close to a pure sine wave. A modified sine wave output is satisfactory for many types of equipment but may cause problems with some types of equipment, including the following:

(1) Some computer and electronic equipment
(2) Some fluorescent lights with electronic ballasts
(3) Some tools with variable speed motor controls
(4) Some battery chargers
(5) Some medical equipment
(6) Some other equipment

The purchaser should identify what equipment is intended to be powered from the power source and verify with the equipment manufacturers that the equipment is compatible with modified sine wave power sources before specifying such a power source.

A.8.7 Portable generator systems are generally designed with an integral fuel tank and controls in one modular package. This allows the system to be picked up and transported to a remote location from the ambulance. Generators designed for portable use should be accessible for removal. These generators are generally not suited for "enclosed" compartment operation or should be mounted on a slide-out tray for adequate ventilation. Such installations require interlocks or a high temperature alarm to ensure that the generator is operated in slide-out condition.

The generator performance specifications should be evaluated carefully to ensure that the required level of performance can be met. Article 445, "Generators," of *NFPA 70, National Electrical Code*, requires that overcurrent protection be provided on portable generators

A.8.9.3 Where the wire could be exposed to temperatures above 194°F (90°C), higher temperature rated wire should be used.

A.8.10.3.4 Similar fixed loads should be paired on opposite legs of the power source where practical. If pairs of receptacles are provided on the same side of the ambulance or on the front or rear of the ambulance, they should be connected to opposite legs of the power source. If two 120 volt cord reels are provided, they should be connected to opposite legs of the power source. 120/240 volt cord reels should always be connected to both legs of the power source.

A.8.11 Where the wire could be exposed to temperatures above 194°F (90°C), higher temperature rated wire should be used.

A.8.11.6.1 Locations in which flexible cord might be damaged include but are not limited to compartment walls and floors, exposed outside areas, and exposed interior areas near equipment or walkways.

A.8.12.3 Common connectors and terminations that comply with these requirements include but are not limited to the following:

(1) Welded or brazed connectors
(2) Crimped connectors
(3) Soldered connections that are mechanically secured before soldering
(4) Screw-type positive pressure connectors
(5) Ring terminals
(6) Hooks
(7) Upturned spade
(8) Crimped-on pins

A.8.12.4 The following switch terminology can be helpful in understanding the different types of switches.

One Pole (1P) or Single Pole (SP). A switch device that opens, closes, or changes connections in a single conductor of an electrical circuit.

Two Pole (2P) or Double Pole (DP). A switch device that opens, closes, or changes connections in both conductors of the same circuit.

Two Circuit (2 CIR). A switch device that opens, closes, or changes connections In a single conductor of two independent circuits.

Single Throw (ST). A switch that opens, closes, or completes a circuit at only one of the extreme positions of its actuator.

Double Throw (DT). A switch that opens, closes, or completes a circuit at both extreme positions of its actuator.

Normally Open (NO). A switch in which one or more circuits are open when the switch actuator is at its normal or rest position.

Normally Closed (NC). A switch in which one or more circuits are closed when the switch actuator is at its normal or rest position.

Switches are rated for the type of load they are designed to control. Switch ratings include the following:

(1) Resistive
(2) Inductive
(3) Horsepower (i.e., motor loads)
(4) Tungsten (i.e., incandescent lamp loads)
(5) Alternating current
(6) Direct current

The ampere rating of a given switch is dependent on the type of load. In particular, switches used to control dc circuits should have the appropriate dc rating.

A.8.12.4.2 In lieu of a switch-rated circuit breaker, a standard circuit breaker could be used with a separate switching device.

A.8.12.5 The purchaser should specify the number and location of receptacles that are needed to operate the devices to be powered by the system. The purchaser should specify the NEMA number (if applicable), manufacturer, and style of the receptacles desired. For other than NEMA-type receptacles, the purchaser should additionally specify the wiring configuration

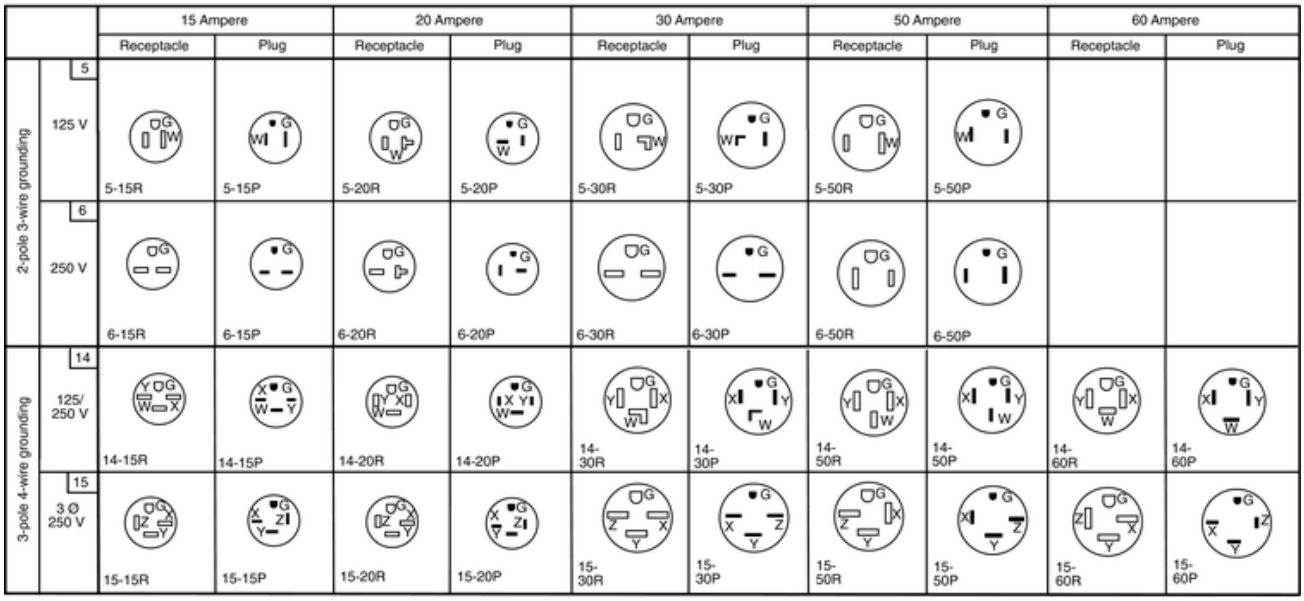
A.8.12.5.6.3 If the off-road ambulance is to ford water, the receptacle distance should be increased above 30 in. (750 mm). The purchaser should review the proposed height for any receptacles on the ambulance and specify a higher mounting height if desired.

A.8.12.5.11 While NEMA configurations as defined in NEMA WD 6, *Wiring Devices — Dimensional*

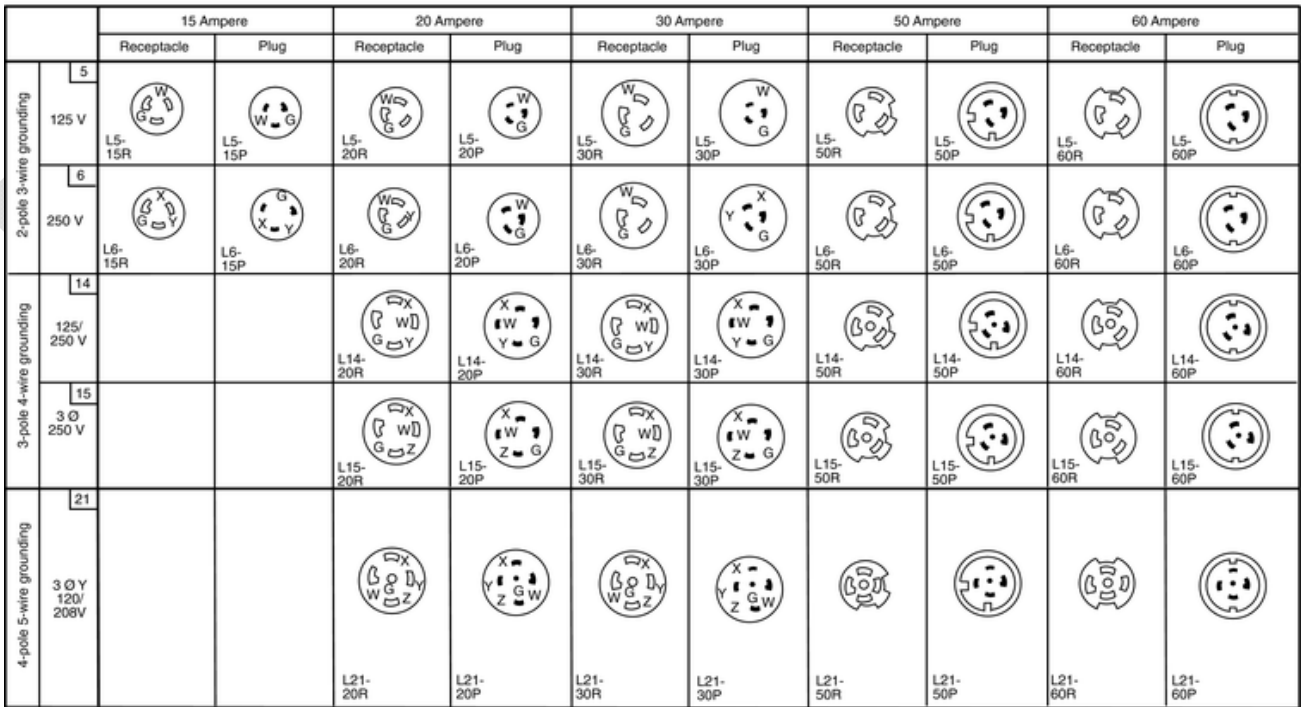
Requirements, are recommended to promote compatibility of equipment during mutual aid operations, other configurations are in use and have been adopted by various ambulance services .

Acceptable NEMA-type plug and receptacle configurations for various ac voltage and current ratings are shown in Figure 8.12.5.7.

NONLOCKING PLUGS AND RECEPTABLES



LOCKING PLUGS AND RECEPTACLES



NEMA WD-6, Wiring Devices—Dimensional Requirements, by permission of National Electrical Manufacturers Association. Copyright 2002 by National Electrical Manufacturers Association.)

The letter “R” following the configuration number indicates a receptacle, and the letter “P” denotes a plug. For example, the nonlocking, 15-ampere, grounding receptacle found in most homes is configuration 5-15R and accepts a three-prong plug in the configuration of 5-15P.

Locking-type plugs and receptacles are designed to prevent accidental disconnection when subjected to moderate pull-apart loads. Neither locking nor nonlocking connectors are designed to withstand the loads that can be created when pulling long cords up buildings and stairs.

A.8.13.5 A suggested minimum capacity of a reel is at least 100 ft (30 m) of cord rated to carry 20 amps at 120 volts ac. When sizing the reel, extra capacity should be provided when multiple receptacles are attached to the cord stored on the reel.

A cord reel to supply a single 120 volt circuit requires three collector rings and three conductors in the cord, for line, neutral, and ground. If the power source has 120/240 volt outputs, as most power sources do, a second equivalent circuit with the same rating requires only one additional conductor, because the neutral and ground can be common to both circuits. Thus, with approximately 25 percent more reel space and cord cost, the cord reel can supply twice the number of lights or other loads.

A.8.13.6 Table A.8.13.6 lists the suggested cord size for cord reels based on the desired circuit ampacity and the cord length. All cord reels with one or more outlets should be rated at 15 amps or greater.

Table A.8.13.6 Wire Size (AWG) for Various Electrical Cord Lengths

Circuit Ampacity	Cord Length					
	50 ft (15 m)	100 ft (30 m)	150 ft (45 m)	200 ft (60 m)	250 ft (75 m)	300 ft (90 m)
15	12	12	12	12	10	10
20	12	12	12	10	10	8
25	12	12	10	10	8	8
30	10	10	10	8	8	6
35	8	8	8	8	6	6
40	8	8	8	8	6	6
50	6	6	6	6	6	4

For heavy loads such as large smoke fans and hydraulic rescue tool power plants, the purchaser should consider 240 volt units instead of 120 volt units. This will allow the use of smaller cords and reels. For example, a 200 ft (60 m) reel to supply a hydraulic rescue tool (HRT) power plant that draws 15 amps at 240 volts would require 12 gauge wire. The same power unit in a version to run on 120 volts would draw 30 amps and would require 8 gauge wire.

Cord reels for three-phase power or other specialized applications should be designed with the assistance of a qualified electrical engineer.

A.8.13.7 The purchaser may want to specify that the cord on the reel be provided with a disconnect means within 18 in. (457 mm) from the reel for cord removal if the cord is 8 AWG or smaller. A disconnect makes it easier to replace damaged cord or to use the cord to extend another cord, although it reduces the capacity of the reel and makes it harder to coil the cord on the reel.

A.8.13.8 The purchaser might want to color code the cord or cord reel to identify the voltage.

A.8.13.9.2 It might be advantageous to specify a remote power distribution box that has a provision for hanging the unit from a door or ladder

A.8.13.9.5 The lamps used in this application should be rough-service type. Scene lighting around the remote power distribution box can be provided with an integral, mechanically protected light fixture

A.8.13.9.5.1 For increased visibility, reflective tape can be applied to the distribution box

A.9.1.1 The purchaser might wish to have the entire low voltage electrical system and warning device system certified by an independent third-party certification organization.

A.9.2 The purchaser should consider the range of temperatures in which the power source is to be operated. If extreme conditions are anticipated, the purchaser should specify the test conditions that are desired.

A.9.2.3 The purchaser should check the polarity of the wiring in a building prior to interconnecting the ambulance mounted electrical system to the electrical system in a building.

A.9.2.7 It is important that the power source meet the purchaser's requirements for output. Power sources may be advertised with power ratings for operating conditions that are more favorable than the conditions that might be encountered in ambulance use. Some power sources are advertised at peak output or intermittent duty ratings and not the continuous duty output required for ambulances. The power source manufacturer and ambulance manufacturer might need to establish a reduced rating that is appropriate for ambulances. The standard calls for two steps. The power source manufacturer provides a declared rating for 120°F (49°C) air inlet temperature and 2,000 ft (600 m) altitude for the minimum clearance and ventilation indicated on the declaration *(see 8.5.10)*. Then the ambulance manufacturer verifies that the rating printed on the power source specification label can be attained during the line voltage load test *(see 9.2.7)*.

Generator Set Rating. Auxiliary engine–powered generator sets are the type of power source most likely to require a reduction from advertised ratings, and generator set literature usually provides rating correction factors for altitude and temperature. These factors could be based on standards for engines, such as ISO 3046-1, *Reciprocating internal combustion engines — Performance — Part 1: Declarations of power, fuel and lubricating oil consumptions, and test methods — Additional requirements for engines for general use*, and SAE J1349, *Engine Power Test Code — Spark Ignition and Compression Ignition — Net Power Rating*; standards for generators, such as NEMA MG 1, *Motors and Generators*; or manufacturer testing. As an example of how altitude and temperature affect output capability, consider a typical 10 kW generator set with 0.8 generator efficiency and naturally aspirated diesel engine that is rated at 500 ft (150 m) and 85°F (30°C) for continuous operation without overload or reserve capacity. ISO 3046-1 indicates a factor of -2.1 percent output per 10°F (5.5°C) ambient increase, and a -2.6 percent per 1000 ft (300 m) altitude increase. Generator output is also affected by temperature [about -0.5 percent per 10°F (5.5°C)] and altitude (small and ignored in this example). There is also an effect from combining engine and generator into a generator set due to each heating the other. This may require an additional factor of -1 to -4+ percent per 10°F (5.5°C), depending on the effectiveness of the cooling system and temperature (the factor increases with increasing temperature). Altogether, these factors suggest the 10 kW generator set in this example is capable of about 8.8 kW at the maximum temperature of 110°F (43°C) and altitude of 2,000 ft (600 m) specified in the standard. Another way to view this result is that an 11.4 kW generator set would be required to provide 10 kW at 110°F (43°C) and 2,000 ft (600 m).

Where there is concern that installation or operational circumstances could cause power source intake air to heat above 120°F (49°C) or where the flow of cooling, induction, or exhaust air is more restricted than what is allowed by the manufacturer's literature, advance consultation with the power source manufacturer(s) could help in the selection of a power source that will pass the ambulance test with an output that meets the purchasers needs. Also, weather, like altitude, can affect air density and thus engine and generator set output. The combined effect of altitude and weather is reported as barometric pressure on local weather reports. Low barometric pressure will reduce engine and generator set output capability. High barometric pressure (usually clear cold days) will increase engine and generator set output capacity.

Other Power Source Types. Some output correction factors described in the generator set example apply to other types of power sources, depending on circumstances. For example, PTO and hydraulically driven generators also rely on engine power, but the engine will usually have substantial reserve power, so increased altitude or temperature will not affect their power supply rating. Regardless, best practice for longest life and lowest

maintenance is to provide unrestricted airflow at the lowest temperature.

Annex B Informational References

B.1 Referenced Publications.

B.1.1 NFPA Publications.

B.1.2 Other Publications.

B.2 Informational References.

B.3 References for Extracts in Informational Sections.