



Designation: F 1230 - 89

AMERICAN SOCIETY FOR TESTING AND MATERIALS

1916 Race St., Philadelphia, Pa. 19103

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Standard Specification for Minimum Performance Requirements for Emergency Medical Service (EMS) Ground Vehicles¹

This standard is issued under the fixed designation F 1230; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers minimum performance and safety requirements for EMS ground vehicles used:

1.1.1 In the transportation of the sick and injured to or from an appropriate medical facility while basic or advanced, or both, life support services are being provided,

1.1.2 In the delivery of interhospital critical transport care,

1.1.3 In the delivery of nonemergency, medically required, transport services, and

1.1.4 In the transportation and delivery of personnel and supplies essential for proper care of an emergent patient.

1.2 It includes the performance standards for necessary materials, equipment, and systems to the levels outlined in recognized standards, whether clinical or vehicular.

1.3 The document is divided into two sections. Section A describes those vehicles used primarily for responding to and for transporting and treating the patient while en route to an appropriate medical facility. Section B will be developed at a later date and will describe those vehicles primarily used for transporting the nonemergency patient, for transporting essential personnel or equipment, or both, to and from a location where emergency medical care is required, or for transporting patients in areas not accessible by ambulances described in Section A.

1.4 This document establishes criteria that shall be considered in the performance, specification, purchase and acceptance testing of ground vehicles for EMS use.

1.5 This document does not define the staffing of ground vehicles or the clinical practice of emergency medicine.

1.6 The entire document should be read before ordering an ambulance, in order to be knowledgeable of which equipment is standard, and which options are desired. Due to the variety of ambulance equipment or features, some options may be incompatible with all chassis manufacturers' models. Detailed technical information is available from the chassis manufacturers.

1.7 The sections in this specification appear in the following sequence:

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¹ This specification is under the jurisdiction of ASTM Committee F-30 on Emergency Medical Services and is the direct responsibility of Subcommittee F30.01 on EMS equipment.

Current edition approved July 31, 1989. Published November 1989.

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2. Referenced Documents

2.1 ASTM Standards:

B 117 Method of Salt Spray (Fog) Testing²

F 1177 Terminology Relating to Emergency Medical Services³

2.2 SAE Standards:⁴

J 163 Low Tension Wiring and Cable Terminals and Splice Clips

J 537 Storage Batteries

J 541 Voltage Drop for Starting Motor Circuits

J 553 Circuit Breakers

J 561 Electrical Terminals, Eyelet and Spade Type

J 562 Nonmetallic Loom

J 683A Tire Chain Clearance, Trucks, Buses, and Combinations of Vehicles

J 689 Approach, Departure, and Ramp Breakover Angles

² Annual Book of ASTM Standards, Vol 03.02.

³ Annual Book of ASTM Standards, Vol 13.01.

⁴ Available from Society of Automotive Engineers (SAE), Inc., Standards and Recommended Practices, 400 Commonwealth Drive, Warrendale, Pa. 15096.





J 928 Electrical Terminals, Pin and Receptacle Type
 J 1127 Battery Cable
 J 1128 Low Tension Primary Cable
 J 1292 Automobile, Truck, Truck-Tractor, Trailer, and Motor Coach Wiring
 J 1349 Engine Power Test Code, Spark Ignition and Diesel
 2.3 *Other Standards:*
 Federal Standard No. 297 Rustproofing of Automotive Vehicles⁵
 49 CFR 393 Federal Motor Carrier Safety Standards (FMCSR)⁵
 AMD Standard 001 Static Load Test for Ambulance Body Structure⁶
 AMD Standard 005 Ambulance Electrical Systems⁶
 KKK-A-1822B Federal Specification for Ambulance⁷

3. Terminology

3.1 Descriptions of Terms:

3.1.1 *chassis manufacturer*—a person(s) who manufacture(s), as a minimum, a frame and chassis structure, power train, steering system suspension, and braking system that requires further manufacturing operations to become a complete vehicle.

3.1.2 *emergency medical service (EMS)*—services utilized in responding to a perceived need for immediate medical care to prevent death or aggravation of physiological or psychological illness or injury.

3.1.3 *ground vehicle*—a vehicle that provides an environment for safe and efficient emergency care at the scene as well as during ground transport.

3.1.4 *recycled material*—a material which has been collected or recovered from solid waste, and reprocessed to become a source of raw materials from which fabrication or construction of new products takes place. Used or rebuilt equipment, material or components shall not be used unless supplied by the end user.

3.1.5 *star of life*—a symbol used to identify a vehicle that meets minimum performance requirements for emergency medical services.

3.1.6 *type I vehicle*—conventional truck, chassis-cab with modular vehicle body. The chassis-cab shall accommodate subsequent mounting of a modular, transferrable, and equipped EMS ground vehicle body conforming to the requirements contained herein.

3.1.7 *type II vehicle*—standard van, integral cab-body vehicle. Suitable for conversion/modification, and equipping as an EMS ground vehicle conforming with the requirements contained herein.

3.1.8 *type III vehicle*—standard “cut-away” van, integral cab-body or containerized, transferable modular vehicle body. The chassis or front section sub-chassis shall be suitable for fabrication, conversion, modification and equipping as an EMS ground vehicle conforming with the requirements contained herein.

⁵ Available from Federal Standards and Specifications, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

⁶ Available from Ambulance Manufacturer's Division, 4907 Cordell Avenue, Bethesda, MD 20814.

⁷ General Services Administration, Specification Unit (WFSIS), 7th and D Streets, SW, Washington, DC 20407.

3.1.9 *type IV vehicle*—suburban-type vehicle equipped with OEM four wheel drive. The chassis shall be suitable for conversion, modification and equipping as an EMS ground vehicle, conforming with the requirements contained herein. This vehicle is intended for use where transport conditions are unsuitable for type I, II, and III vehicles (for example, off-road, rough terrain, inclement weather).

3.1.10 *vehicle manufacturer*—a person(s) who adds to a chassis the necessary components and systems to allow it to perform its intended function.

3.2 *Definitions*—Also see Terminology F 1177.

4. Materials

4.1 To ensure optimal performance and safety, materials used in the construction of ground vehicles should, unless otherwise specified, meet or exceed the following criteria:

4.1.1 *Wood Products*—Wood products should not contain formaldehyde binders or resins and, if plywood, should be industry standard solid core, no void for structural elements and floors.

4.1.2 *Wiring*—Wiring added by the vehicle manufacturer shall be SAE type SXL or equivalent.

4.1.3 *Looming*—Looming added by the vehicle manufacturer shall be type FR and fire resistant or equivalent.

4.1.4 *Insulation*—Insulation shall not contain urea-formaldehyde foam or asbestos.

5. Requirements

5.1 General Vehicle Types and Floor Plan:

5.1.1 The vehicle chassis, the materials used in conversion, and the equipment described in this specification shall be of current commercial quality and design of the type and class specified. The vehicle shall be complete with the operating accessories as required herein; furnished with such modifications and attachments as may be necessary to enable the vehicle to function reliably and efficiently in its intended operating environment. The design of the vehicle and the required equipment shall permit accessibility for servicing, replacement, and adjustment of component parts and accessories with minimum disturbance to other components and systems.

5.1.2 *Floor Plan of Patient Compartment*—Unless otherwise specified, the floor plan of the vehicle shall be designed to allow transportation of patients and crew as follows: one patient (primary patient) on a wheeled elevating stretcher/cot, mounted either against the left (driver's side) wall of the patient compartment or center mounted; one patient (secondary patient) on a folding stretcher or combination stretcher chair secured to the squad bench; and one seated emergency medical service attendant.

5.2 *Vehicle, Components, Equipment, and Accessories*—The vehicle chassis, body or module, emergency medical care equipment, devices, accessories, and electronic equipment used in constructing the vehicle shall be of high quality, commercial grade, tested and certified to meet or exceed the requirements of this document. The vehicle shall comply with all Federal Motor Vehicle Safety Standards (FMVSS), and other federal or state regulations, or both, applicable or required for the date of manufacture. The chassis, components, equipment, and accessories shall be as represented in the respective manufacturer's current technical data. Vehicle

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manufacturer shall not make modifications that violate the chassis manufacturer's warranty. The components and equipment used in the vehicle conversion need not be products of the same manufacturers, but the builder shall provide standardization, and interchangeability between similar vehicles, alike equipment, items, and accessories unless otherwise specified.

5.3 *Vehicle Operation, Performance, and Physical Characteristics:*

5.3.1 Operation and Performance—All performance requirements shall be met with the vehicle equipped with all required equipment and devices installed and operating at maximum power-consuming condition, that is, air conditioning, lights, radio(s). During all environmental testing (for example, heating and air-conditioning systems), the parameters of the environmental chamber, such as wind speed, temperature variation, and relative humidity, shall be as described in 5.12.

5.3.2 Temperature Conditions—The vehicle shall be capable of unimpaired storage and satisfactory performance in ambient temperatures of -30°F to $+125^{\circ}\text{F}$, when serviced and maintained in accordance with the chassis manufacturer's recommendations as described in 6.5.7.

5.3.2.1 All types of medical devices used in vehicles should maintain their safety and performance characteristics following storage between -34°C (-30°F) and 65°C (149°F). In addition, medical devices should maintain their safety and performance characteristics while operating between -21°C (-5°F) and 46°C ($+115^{\circ}\text{F}$). Devices that cannot be stored or operated at these respective temperatures must be placarded with safe storage temperature range. The equipment instruction manual should also provide such information.

5.3.2.2 All medical devices used in the vehicles should maintain their safety and performance characteristics following equilibrium at humidity extremes encountered over their anticipated storage and operating temperature range. Medical devices operated in the field or in vehicles will encounter humidities over the range of 15 to 95 %. Due to the dependent relationship of temperature and humidity, not all values within this suggested range of relative humidities occur at each point within the suggested temperature range. Therefore, a relative temperature/humidity chart must be used to develop humidity extremes for the temperature suggested.

5.3.2.3 A suggested test protocol can be found in Development of Environmental Test Methods for Non-Implantable Medical Devices NTIS PB296892, April 1979. Manufacturers of medical devices shall provide certifications (see 6.3.2).

5.3.3 Noise and Sound Level Limits, Exterior—The exterior noise level produced by the vehicle, except siren and other audible warning devices, shall not exceed federal regulations.

5.3.4 Vehicle Performance—The vehicle shall provide a smooth, stable ride, with minimum noise and vibration. Test under 6.5.2.

5.3.5 Brakes—The vehicle as delivered to the user shall comply with performance values required by Federal Motor Vehicle Safety Standards (FMVSS).

5.3.6 Speed—The vehicle shall be capable of a constant speed of not less than 70 mph, oven dry, hard surfaced, level

roads, at sea level, when tested under normal ambient conditions. Test under 6.5.2.

5.3.7 Acceleration—The vehicle shall have a minimum average acceleration rate at sea level of 0 to 55 mph within 30 s. Test shall be performed under normal ambient conditions. Test under 6.5.2.

5.3.8 Gradability—The vehicle shall be capable of ascending at least 100 ft from a standing start, and stop and restart three consecutive times during a 6-min period while ascending a dry, smooth slope having a minimum grade of 25 % without stalling or overheating while being tested. Gradability tests shall be performed under normal road and ambient conditions, under 6.5.2.

5.3.9 Fuel Range—The vehicle shall be capable of being driven for at least 150 miles without refueling under environmental conditions encountered in 6.5.2.

5.3.10 Fording—The vehicle shall be capable of three fordings, without stalling the engine, without water entering patient and equipment compartments, and with sufficient residual braking to stop the vehicle while being driven through a minimum of 8 in. of water at speeds of 5 mph for a distance of at least 100 ft. Test under 6.5.2.

5.3.11 *Vehicle Physical Dimensional Requirements:*

5.3.11.1 Length. Overall length of the vehicle including bumpers and rear bumper step shall allow the vehicle to meet the requirements of 5.3.11.5.

5.3.11.2 Width—The overall (OA) width of bodies for vehicles furnished with single wheels (front/rear) shall not exceed that recommended by the chassis manufacturer in their Body Builders Guide, excluding mirrors and spotlights, except for Type IV vehicles, which shall not be less than 72 in. wide. The vehicle body sides (including fenders) on a chassis with dual rear wheels shall be within ± 2 in. of the overall width of the tires (outside sidewalls) (see 5.4.6 and 5.8.7). The maximum vehicle body width shall not exceed 96 in. excluding mirrors and spotlights.

5.3.11.3 Height—Overall height of the vehicle at curb weight (see 5.4.1) shall not exceed 110 in., including roof-mounted equipment, but excluding flexible radio antenna(e).

5.3.11.4 Ground Clearance—The lowest part of the vehicle when loaded to the G.V.W. shall not exceed chassis manufacturers recommendations of ground clearance. The vehicle's body (skirts) components shall provide not less than 8 in. of running clearance.

5.3.11.5 Angle of Approach, Ramp Breakover, and Departure—The vehicle loaded to the G.V.W. with bumpers and rear step (down if folding style) shall provide not less than the following clearance, measured in accordance with SAE J689:

Approach angle	20°
Ramp breakover	10°
Departure angle	10°

5.4 *Vehicle Weight Ratings and Payload:*

5.4.1 Curb Weight—Curb weight is the total weight of the complete vehicle and is defined as: chassis, cab, body, and the associated permanently mounted equipment specified, excluding radios and portable or secured equipment, or both, with a full complement of fuel, lubricants, and coolant.

5.4.2 Payload Allowance—A minimum of 1200 lb for single rear wheel vehicle, and 1500 lb for dual rear wheel vehicle's payload allowance shall be provided over and above the curb weight (see 5.4.1) of the vehicle.

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consist of personnel, patients (computed at 150 lb per occupant), medical and communications equipment, and miscellaneous support supplies and devices appropriately distributed within the vehicle.

5.4.3 Gross Vehicle Weight Rating (GVWR)—The chassis manufacturer's gross vehicle weight rating shall exceed the combination of the vehicle's curb weight and payload. Manufacturers shall provide a rating label showing the actual gross vehicle weight rating (GVWR) of the vehicle (also see 5.17).

5.4.4 Weight Distribution—The weight distribution of a properly loaded vehicle on a level surface shall be such that not less than 30 % of the vehicle's weight is on the front suspension (reference FMVSS 105). In addition, the curb weight (see 5.4.1) on the right and left wheel of each axle of a completed ambulance shall be weighed to determine weight distribution. The curb weight and gross vehicle weight between the right and left side of a given axle, when on a level surface, shall be within 5 % when calculated in accordance with 6.5.1.

5.4.5 Center of Gravity—The vehicle manufacturer shall ensure that the center of gravity of the completed vehicle complies to the parameters set by the chassis manufacturer.

5.4.6 Ratings—Chassis and component ratings shall be the manufacturers' published ratings, and shall not be raised above the manufacturers' rating. When ratings are not published or chassis has been modified, the verification data of the component manufacturer's rating shall be provided.

5.4.7 Cab to Axle (CA), Type I and III Vehicles—Cab to axle (CA) dimension of the vehicle chassis shall permit a minimum of 50 % of the outside body length forward of the rear axle centerline, plus cab to body clearance. Bodies designed with wheel openings shall have the rear wheels centered, ± 2 in. longitudinally within the opening and ± 0.5 in. laterally.

5.5 Chassis, Engine, and Components:

5.5.1 Chassis-Frame—The chassis-frame and components shall be capable of withstanding on and off road service, any special service, and equipment requirements. Test under 6.5.2.

5.5.2 Vehicle Lubrication—The chassis components, devices, accessories, and equipment requiring lubrication maintenance shall be fully equipped with lubrication fittings.

5.5.3 Engine:

5.5.3.1 Power Unit—The power unit shall meet or exceed the required vehicle performance (see 5.3), at not more than the engine manufacturer's recommended operating engine range. It shall provide an even flow of power at all rpm without noticeable vibration or overheating of engine parts.

5.5.3.2 Engine Low Temperature Starting—The engine shall start satisfactorily without the aid of preheating devices at -20°F when a gasoline engine is furnished, and 10°F when a diesel engine is specified. Auxiliary heating and/or starting devices shall be provided to meet other more stringent specified starting conditions. A verification test is to be performed during environmental tests. Electric heater(s) shall be switched (on and off) and connected to the vehicle (see 5.6.5 and Fig. 1) so they can only be energized from utility power.

5.5.3.3 Engine—Engine horsepower and torque requirements shall be sufficient to comply with the requirements specified in 5.3. Net horsepower ratings shall conform to

SAE J1349. Vehicle(s) being offered/supplied with catalytic converters shall be identified.

5.5.4 Chassis Components:

5.5.4.1 Air Pollution Control—Vehicle emission levels shall not exceed federal regulations unless exempted by state or EPA.

5.5.4.2 Fuel System—The fuel system shall conform to FMCSR, Subpart E, 393.65 and 5.3.9 herein. If more than one tank is furnished, tanks shall be interconnected, but separately controlled, and shall have a dash-mounted fuel gauge controlled by a selector switch or dual gages, which will permit separate fuel level readings for each tank. All four-wheel drive and other vehicles intended for off the road use shall have the fuel tank(s) protected by a shield (skid-plate) with adequate drainage, and shall be located in an area which will be free from hazards encountered in off-road, cross-county operation.

5.5.4.3 Cooling System—The vehicle manufacturer shall provide the heaviest duty components and maximum size cooling system available from the chassis manufacturer applicable to the vehicle offered. The cooling system shall maintain the engine at safe operating temperatures at all drivable altitudes and grades encountered during on and off road vehicle use. If liquid cooled, the engine cooling system shall be a closed, air free liquid state type, with a coolant overflow recovery tank and compensating system.

5.5.4.4 Exhaust System—The vehicle shall be equipped with an exhaust system in accordance with FMCSR, Part 393.83. The exhaust system shall be properly heat shielded to chassis manufacturer's recommendations and secured and a hanger shall be provided within 12 in. of the termination of the tailpipe. The exhaust shall discharge at the side(s) of the ambulance away from the door(s), to minimize fumes and contaminants entering the interior. The tailpipe outlet shall not terminate within 6 in. of the vertical axis of the fuel tank filler opening and should extend at least one inch beyond vertical body side.

5.5.5 Drive Train:

5.5.5.1 Drive Train Components—The drive train and components' torque capacity shall meet or exceed the maximum torque developed in the lowest gear ratio by the engine. Transmission and controls shall comply with FMVSS 101 and 102.

5.5.5.2 Automatic Transmission—A continuous drive automatic transmission shall be provided. The transmission shall provide not less than three speeds forward and one reverse and shall be equipped with the chassis manufacturer's heaviest duty oil-cooler.

5.5.5.2(a) External Automatic Transmission Heavy-duty Oil Cooler—When specified, a heavy-duty external transmission oil cooler in addition to the OEM's basic cooler (see 5.5.5.2) shall be provided and installed in series, in a suitable location except behind the radiator.

5.5.5.2(b) Manual Transmission—When specified, a manually shifted, synchronous type transmission having at least four forward speeds and one reverse speed shall be provided. The chassis manufacturer's largest heavy-duty clutch available for the engine model offered shall be provided.

5.5.5.3 Transfer Case for Four-Wheel Drive Vehicles—

These vehicles shall be furnished with two speed transfer



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12 VOLT ELECTRICAL SYSTEM-FUNCTIONAL DIAGRAM (TYPICAL)

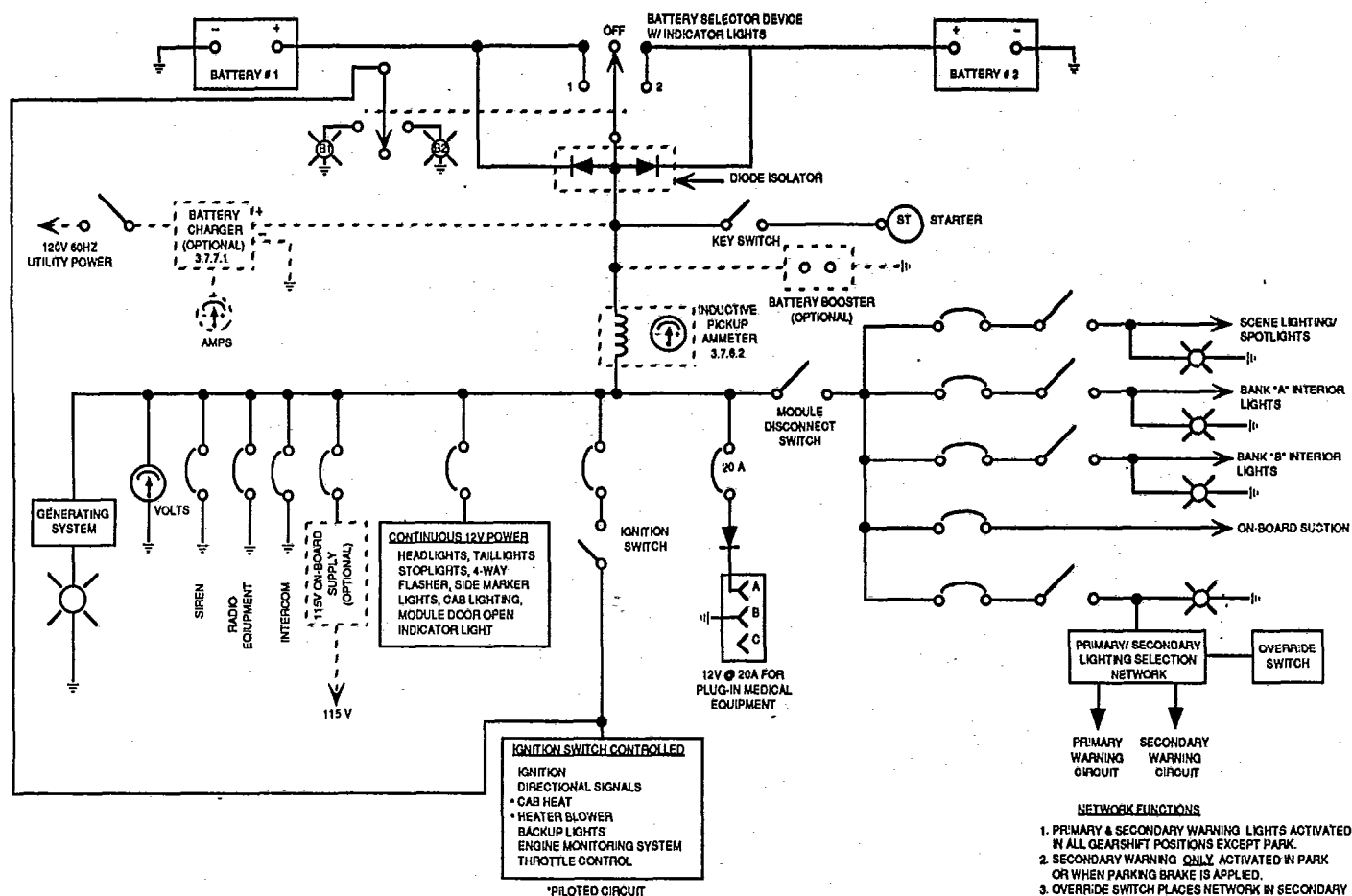


FIG. 1 Electrical System Diagram

cases and a positive traction, limited slip, or automatic locking type rear-end differential. A shift pattern located on the shift knob or decal within the cab shall be provided. Automatic front-wheel drive hubs shall be furnished on 4x4 vehicles when required.

5.5.5.3(a) Heavy-Duty Skid Plate—Vehicles intended for off-road use shall have a heavy-duty skid plate protecting engine and transmission from ground contact. The skid plate shall be demountable for servicing the engine and transmission. Openings shall be provided for routine maintenance. For fuel tank protection, see 5.5.4.2.

5.5.5.4 Drive-Line—The drive-line (shaft, U-joints, etc.) shall be balanced and supported to perform throughout the design speed range without whipping or vibrating. Modifications resulting from lengthening the wheelbase shall be of chassis manufacturer's approved design. Appropriate drive shaft protection shall be provided on all vehicles to protect against pole vaulting in the event of drive shaft or U-joint failure.

5.5.5.5 Axle, Ratings, Ratios—Axle ratings shall be at least equal to the load imposed on each axle, measured at the ground, when vehicle is loaded to GVW. Unless otherwise specified, chassis manufacturers shall provide the appropriate axle ratio (highest applicable lowest reduction) and on

Type I and III vehicles chassis manufacturer's "wide dual" rear axles.

5.5.5.6 Brake System, Service, and Parking—Chassis manufacturer's heaviest duty power assisted brakes, linings, and parking brake shall be furnished on the chassis model offered. When specified, chassis manufacturer's anti-skid braking systems shall be provided.

5.5.5.7 Special Traction (Rear End) Differential—When specified, a positive traction, limited slip, or automatic locking type differential shall be furnished.

5.5.5.8 Suspension—The vehicle shall be equipped with matched (from side to side) sets of springs, torsion, or air suspension system components. Components shall have a rated capacity greater than or equal to the load imposed on each member. For better riding quality, vehicle springs shall have chassis manufacturer's lowest clamped deflection rating for the model offered. Suspension stabilizer devices shall be furnished from the chassis manufacturer for the model chassis furnished when available. Otherwise, after market suspension stabilizers may be provided when specified.

5.5.5.9 Spring Stops—The chassis manufacturer's standard spring bumpers and axle stops shall be furnished. The stops and bumpers shall prevent the wheel and axles from striking the engine, oil pan and fenders and body

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under all conditions of operation.

5.5.5.10 Shock Absorbers—Shock absorbers, double-acting type, heaviest duty available from chassis manufacturer for model offered, shall be furnished on the front and rear axles. Type IV vehicles shall additionally be furnished with chassis manufacturer installed quad front shocks.

5.5.6 Steering—Unless otherwise specified, the chassis manufacturer's standard power-assisted steering shall be furnished.

5.5.7 Wheels—Wheels shall conform to the recommendations of the Tire and Rim Association, Inc., and shall be alike in type, size, and load rating for all wheels on the vehicle including the spare.

5.5.8 Tires—Unless otherwise specified, tires shall be regular highway tread, chassis manufacturer's standard tires furnished for the GVWR of the vehicle. All tires furnished shall be alike and comply to FMVSS 120 (use of radial and bias ply tires together is not recommended).

5.5.9 Inner Tubes—When tube type tires are furnished, inner tubes shall conform with the recommendations of the Tire and Rim Association, Inc.

5.5.10 Spare Tire and Storage—Unless otherwise specified, one inflated spare wheel/tire assembly identical to those on the vehicle shall be furnished. The spare assembly shall be stored in an accessible area. Access door shall be fitted with suitable latch. This spare assembly shall be accessible without removal of the patients from the compartment. The spare assembly and tools shall have restraining device(s) to eliminate rattling. The carrier design shall enable removal and mounting of the spare assembly using only the tools specified in 5.5.13.

5.5.11 Tire Chain Clearance—Tire chain clearance (SAE J683A) shall be provided for the vehicle at the right and left side driving wheels. Sufficient chain clearance shall be provided to permit off-road operation with the vehicle loaded to the GVW.

5.5.12 Wheel-Tire Balancing—Wheel/tire, hubs, and brake drum assemblies of the vehicle shall be in balance to a minimum of 60 mph (static or dynamic). Test per 6.5.2.

5.5.13 Tools (Tire Changing)—Unless otherwise specified, the vehicle shall be furnished with tools required for exchanging mounted tire assembly with the spare assembly and shall include at least a jack, jack handle, and wheel nut wrench. The jack height, when closed, shall permit its location under the axle or other satisfactory lift point at any wheel with the tire flat. The jack, without having to block the jack, shall be capable of raising any wheel of the loaded vehicle to a height adequate to permit removal and replacement of the wheel and tire assembly. Tools shall be stored in accordance with 5.5.10.

5.6 Electrical System and Components:

5.6.1 Electrical System (see Fig. 1)—The vehicle electrical system shall be equipped with, but not limited to, the following: dual identical 12 volt batteries, generating, starting, lighting, ignition, visual and audible warning systems, specified electronics equipment and devices including master consoles located in the cab and patient compartment, and other specified accessory wiring. The electrical systems and equipment shall comply with all applicable FMVSS, FMCSR, and all applicable SAE recommended standards and practices whether or not specifically referenced in this

document while complying with the subparagraphs herein. All electrical and electronic components shall be selected to minimize electrical loads thereby not exceeding the vehicle's generating system capacity. All electrical system components and wiring shall be readily accessible through access panels for checking and maintenance. All switches, indicators, and controls shall be located and installed in a manner that facilitates easy removal and servicing. All exterior housings of lamps, electronic devices, and fixtures shall be corrosion resistant and weatherproofed.

5.6.1.1 Electrical fixtures attached to the sides of the ambulance below the 75 inch level shall be near flush mounted, not protrude more than two (2) inches, except for such items as spotlights, and ventilators. All electrical devices and equipment installed which produce RFI, shall include filters, suppressors, or shielding to prevent electromagnetic radiation and the resultant interference to radios and other electronic equipment (see 5.6.9). Vehicles equipped with electronic engine controls shall be immune from interference caused by radio transmissions.

5.6.1.2 In the event of a failure of either lighting circuit, the remaining circuit will provide a minimum of 15 footcandles of illumination measured along the centerline of the cot, which shall be provided by lamps connected to a circuit separate and distinct from the main lighting circuit in the patient compartment.

5.6.1.3 Onboard suction shall be powered by a 12 VDC circuit separate and distinct from the circuit powering the auxiliary 12 VDC outlets. For the purpose of this section, separation and distinction of circuits is defined as separately switched and overload protected, while powered by the same main bus.

5.6.1.4 Warning Indicators—The electrical system shall incorporate a warning light panel located in the driver's compartment. It shall provide indicator lights for showing when patient compartment entrance door(s) (side and rear) and exterior storage compartments are open (see 5.9.8), and when applicable which battery(s) are selected by the battery selector switching system (see 5.6.4). The "door open" warning light shall be red, flash, and approximately ½ in. in diameter, or equal area. The battery indicator lights shall be green with a lens approximately ½ in. in diameter, or equal area. Warning indicators shall be identified and marked per 5.6.8.

5.6.2 Wiring Installation—The vehicle body and accessory electrical equipment shall be served by circuit(s) separate and distinct from vehicle chassis circuits. All wiring provided by the vehicle manufacturer shall be copper and conform to all the SAE J1292 requirements and shall have type SXL (control cables less than 18 gage may be type GPT) high temperature thermoplastic or better insulation conforming to SAE J1127 and J1128. The wiring shall be permanently color coded or permanently marked, or both, at least every 4 in. over the entire length of the wire for identification with easily read numbers or letters, or both, and routed in conduit or high temperature looms conforming to SAE J562 as applicable. All added wiring shall be located in accessible, enclosed, and protected locations and kept at least 6 in. away from exhaust system components. Electrical wiring and components shall not terminate in the oxygen storage compartment. Wiring necessary for passing

through an oxygen compartment shall be routed in a metallic conduit (see 5.10.3). All conduits, looms, and wiring shall be secured to the body or frame with insulated metal cable straps in order to prevent sagging and movement which results in chafing, pinching, snagging, or any other damage. Nonmetallic cable straps may be used for interior mounting of harnesses not more than four wires of 12 gage or less. All apertures on the vehicle shall be properly grommited for passing wiring and conform to SAE 1292. All items used for protecting or securing the wiring shall be appropriate for the specific application and be standard automotive, aircraft, marine, or electronic hardware. All looming shall be type FR or better. All wiring looms passing through the firewall, in addition to being grommited, shall be sealed with fire-barrier sealant. All cable ties shall be rated at 125 % of operating temperature.

5.6.2.1 Wiring Criteria—All wiring devices, switches, outlets, etc., except circuit breakers, shall be rated to carry at least 125 % of the maximum ampere load for which the circuit is protected.

(a) Uncabled, individual wires smaller than 20 gage shall not be used for ambulance wiring. Conductors smaller than 20 gage must be placed in multiconductor jacketed cables or ribbon cable assemblies with adequate strain relieved termination on either connectors or devices. Conductors smaller than 20 gage are also permissible when totally contained within devices.

(b) A 6-in. service loop of wire or harness shall be provided at all electrical components, terminal, and connection points except where they begin and end on the same panel. All splices and terminals provided shall comply with SAE J163, J561, or J928 as applicable. Soldered connections are acceptable. All wiring between the cab and module in Types I and III shall be interconnected using a connector, terminal block, or terminal strip located near the point of entry into the patient module. Weather protection shall be provided to prevent corrosion of the contact assemblies and all terminals shall be permanently numbered or coded. The connection points shall be readily accessible for inspection and service.

(c) The vehicle electrical system shall incorporate a master circuit breaker panel with circuit breakers which comply with SAE J553, Type I circuit breakers in each circuit. When specified, manual circuit breakers shall be permitted per FMVSS. All manual reset circuit breakers should be accessible to the driver from the normal driving position. Additionally, one 15-A circuit breaker shall be provided for future use. All manual circuit breakers shall be securely mounted, easily removable, and readily accessible for inspection and service. All electrical and electronic components, switches, connectors, circuit breakers, lamps, and indicators, including the vehicle batteries, shall be marked with an easily read identification code number or letter, or both. Complete, highly legible wiring diagrams and schematics, including identification codes and parts list for the ambulance's standard and optional equipment furnished, shall be included in the service manual and be supplied with each ambulance in accordance with 6.5.5. No splices shall be permitted except for connection of "OEM pigtail"-type devices. Butt splices are permitted for connection of OEM pigtail devices. All terminations shall be UL-approved and machine applied per UL standards.

5.6.3 Electrical Generating System—The ambulance shall be equipped with a generating system rated at not less than 120 A at 14 V at idle. Separate generating systems may be used to supply the electrical requirements. Such systems shall be provided with backup systems. The generating system shall be capable of supplying at its regulated voltage, the continuous electrical load which consists of the following electrical equipment and systems: ignition system, headlights (low beam), all FMVSS 108 lights, windshield wipers (low speed), cab air-conditioning (at coldest setting with highest blower speed), communication radio(s) in receiving mode (or equal load, if not equipped), patient module dome lighting (in the high intensity setting), patient module air-conditioning (at coldest setting with highest blower speed), emergency warning lighting system in the daytime "primary" mode (see 5.7.2), scene lights, and 20-A medical load or equal. Additional electrical devices or systems such as additional warning lights, onboard 115 VAC supply, etc., are permitted providing reserve or additional generating capacity is available. The 12-V generating system shall supply the maximum electrical load, at the regulated voltage, at the operating temperature and with an engine speed not exceeding 40 %, if gasoline, and 50 %, if diesel engine, of the furnished engine's SAE net hp, rpm rating. The throttle control device specified in 5.6.3.1 shall control the engine rpm necessary to maintain the heating and air-conditioning systems at full operating capacity, but in no event at less rpm than necessary to maintain the generating system's required output when the vehicle is stationary. The 12-V electrical system shall incorporate an ammeter (see 5.6.3.2), and a voltmeter or voltage warning device (see 5.6.3.3), which are functionally connected as shown in Fig. 1. The final stage manufacturer/supplier shall test each ambulance prior to delivery and provide to the purchaser a written certification (tag) indicating the amount of generating capacity remaining at the regulated voltage operating temperature after supplying the total electrical load as manufactured (including the purchaser options). Testing and tagging shall be in accordance with AMD Standard 005, Ambulance Electrical System.

5.6.3.1 Engine High-Idle Speed Control, Automatic—Unless the chassis manufacturer's recommended engine idle speed can sustain the ambulance's total continuous electrical load, and maximum heating/air-conditioning output as manufactured (see 5.6.3), an engine high-idle speed control shall be provided, which increases the engine (rpm) speed. The device shall be preset so that, when activated, it will operate the engine at the appropriate rpm (see 5.6.3), sustained by the alternate power supply. The device shall operate only when switched to the "On" position and the transmission is in "Neutral" or "Park." The device shall disengage when the operator depresses the service brake pedal, or the transmission is placed in gear, and automatically reengages when the service brake is released, or when the transmission is placed in neutral or park.

5.6.3.2 Ammeter—The electrical system (see Fig. 1) shall incorporate a center scale ammeter which is capable of indicating a current of 125 % of system capacity to or from (charging or discharging) the dual vehicle batteries. The ammeter shall incorporate an external shunt which does not exceed 150 mV at maximum current. The ammeter and

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shunt shall have a combined accuracy of $\pm 10\%$ of the full scale reading. The meter shall be mounted in a location highly visible to the vehicle operator and shall be illuminated for night operation. The shunt shall be protected against physical damage, weather road spray and shall be mounted in an easily accessible location which shall minimize the length of the power cables.

5.6.3.3 Voltmeter or Voltage Monitor—A voltmeter, illuminated for nighttime operation which constantly monitors the 12-V electrical system, and a warning device which indicates abnormally high or low electrical system voltages shall be furnished. The device furnished must be mounted so it is clearly visible to the driver at all times.

5.6.4 Battery System—A dual 12-V battery system with a labeled "Battery Selector Device" shall be furnished. Batteries shall be identical deep cycle, rapid charge with not less than 450 cold cranking amperes at 0°F, with at least 125 min reserve capacity. Each battery shall be independently capable of starting the vehicle in the temperature range specified in 5.5.3.2. Alternative systems with redundant starting capabilities are acceptable. Battery ratings shall conform to SAE J537. Batteries shall be located in accordance with the OEM body builders book and shall be in a ventilated exterior compartment, sealed off from occupant compartments, and shall be readily accessible for servicing and removal. Batteries can be located in the engine compartment except for gasoline-powered vehicles. Unless the "Battery Selector" device is clearly visible to the driver in the seated position, green lights indicating which battery is in use (see 5.6.1.1) shall be furnished. All battery and selector device or switch wiring for starting motor circuits shall meet or exceed the SAE J1127 and SAE J541 requirements for "12-V heavy-duty applications." The selector device shall be capable of selecting either battery separately or both batteries simultaneously. Additionally, the switch or device shall be capable of completely disconnecting both batteries. A diode isolator device (see 5.6.4.2 and Fig. 1) shall be installed which permits simultaneous charging of both vehicle batteries and prevents the removal of the battery load from the alternator when the battery selector switch or device is placed in the "Off" position with the engine running. The electrical system shall include patient compartment outlets for 12-V power (see 5.6.4.3) for medical equipment. A driver compartment console-mounted "module disconnect switch or device" (see 5.6.4.4) shall be provided which controls the equipment as shown in Fig. 1. When specified, a remote (exterior) battery booster connection shall be provided, connected to the vehicle (not battery) side of the battery selector/shutoff switch. (A 24-V starting system is acceptable.)

5.6.4.1 Battery Charger—When required, a 12-V d-c battery charger/conditioner shall be provided. The charger/conditioner shall be connected to the dual 12-V battery system as shown in Fig. 1. The charger shall be capable of supplying a minimum of 10 A charging current, at a charger voltage of 14.0 to 15.0 V, equipped with internal circuitry that monitors the charge level of the batteries. The charger shall be permanently mounted in the vehicle in a properly ventilated and accessible location, and wired to the 115-V a-c utility power as specified in 5.6.5 and Fig. 1. The charger shall include an automatic cutoff that terminates charging when the batteries are fully charged. Controls shall include

on/off switch and a meter that shows the rate of charge.

5.6.4.2 Diode Isolator—A diode isolator device shall be furnished (see Fig. 1), which incorporates (low-voltage drop) "Schottky" diodes. The diodes shall be mounted on a suitable heatsink, be capable of continuously carrying at least 125 % of the maximum charging current to the vehicle battery(s), and have an inverse voltage rating of at least 45 V. The heatsink shall be located in a protected area and not exposed to the elements.

5.6.4.3 Internal 12-V d-c Power—The patient compartment shall be furnished with a 12-V d-c, 20-A capacity, separately protected circuit, with two outlet receptacles. This circuit shall also 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. The Schottky diode shall be heatsink mounted, have an inverse voltage rating of at least 45 V, and also be rated to carry the maximum short circuit current until the circuit breaker opens. The diode shall be physically located in an accessible location and be electrically connected between the circuit breaker and the "action wall" mounted receptacle. Unless otherwise specified, the receptacles shall be a military type connector of the following generic designation: MS3112E12-3S, or its interchangeable commercial equivalent. The polarity of the connector shall be as follows: Pin A—+12V, Pin B—ground, Pin C—not used. The receptacles shall be located on a vertical surface of the "action wall." The mating plug attached to the medical equipment shall be an MS3116F12-3P or its interchangeable commercial equivalent. The polarity for the plug shall be the same as above. Two of these unwired plugs shall be furnished and tagged with polarity requirements and shall be connected to the receptacles.

5.6.4.4 Master Module Disconnect Switch or Device—This switch (see Fig. 1) shall be located on the driver's compartment console and be legibly marked.

5.6.5 One-Hundred and Fifteen-Volt a-c Utility Power—When specified, the vehicle shall be furnished with a 2-wire plus ground sinusoidal 115-V a-c (VAC) wiring system that is separate and distinct from the vehicle's 12-V d-c system(s). The 115 VAC electrical system and associated equipment shall comply with the National Electrical Code and be UL listed. This system is to be used while vehicle is on standby for powering maintenance devices, medical equipment battery chargers, and when specified, vehicle battery charger, engine and battery heaters, and any other device(s) deemed necessary by the purchaser. The 115-V system shall incorporate a ground fault interrupter (GFI) device and a 15-A circuit breaker which can be used as a master 115-V disconnect switch. When an onboard 115 VAC supply is required (see 5.6.5.3), an automatic transfer switch shall be furnished which turns off this 115 VAC supply (interlock) and disconnects its output when the 115 VAC utility power is applied. When the 12 VDC battery charger, and any 115 VAC power plant heater(s), are furnished, they shall be wired so that they can be energized only when the 115 VAC utility power is applied. The 115 VAC onboard generating system shall not be utilized for vehicle interior lighting, such as dome and cotlights, etc.

5.6.5.1 Utility Power Connector—A 15-A (NEMA 5-15P) hospital grade receptacle rated at least 15 A or more if

required with spring loaded cover assembly suitable for wet locations, shall be installed on the driver's side of the ambulance body in close proximity to driver's door, unless otherwise specified, the connection shall be permanently labeled with the following: "This connection is for GFI protected 110–125 volt AC, 60 Hz, 15-ampere (or greater) supply." The reference handbook should indicate that this receptacle shall energize the vehicle's internal 115 VAC circuit from an exterior power source (utility power) and that the circuit supplying the ambulance's 115 VAC power should incorporate ground fault protection. A proper mating, weatherproof, 15-A, or more when required, female receptacle (NEMA 5-15R) shall also be furnished without cable and tagged specifying the size, type of wire necessary, and the polarity of the future hookup.

5.6.5.2 Electrical 115 VAC Receptacles—The patient compartment shall be furnished with two, 2-wire plus ground duplex hospital grade 115 VAC receptacles. Receptacles shall be near flush mounted with one (duplex) outlet located on the vertical primary patient action wall, and the other vertically located at the torso area of the secondary patient (squad bench). Both outlets shall be at least 12 in. from any oxygen outlet. An indicator shall be located within each 115 VAC receptacle as a line monitor indicating a live (hot) circuit. The receptacles shall be labeled with the following: "115 VAC."

5.6.5.3 Solid State Inverter, or Motor-Generator for On-Board 115 VAC Power—When specified, a dc to ac device shall be provided in conjunction with 5.6.5. The device furnished shall be UL listed and capable of delivering at least 750 W of sinusoidal ac power to a resistive load and maintain a frequency of 60 ± 4 Hz. The single phase output voltage shall not rise to more than 135 V nor drop to less than 105 V from no load to full load, at an 80 % power factor, over the normal range of the d-c input voltage (12.5 to 14.5 VDC). The device shall be capable of operating all types of a-c loads including resistive and reactive (either inductive or capacitive) over the temperature range in 5.3.2. The installation shall include an "On-Off" switch to activate the device. This switch shall be located on the EMT's control panel or cab console, have a red "On" indicator, and be labeled with the following: "115 VAC, 750 watts." A decal shall be provided near this switch which states that "when operating the AC system, all unnecessary 12-volt DC electrical loads should be turned off."

5.6.6 Driver Compartment Controls—The vehicle manufacturer shall provide and locate within easy normal reach of the driver the specified controls and instruments. The battery selector (see 5.6.4) and master module disconnect device (see 5.6.4.4) shall be supplied with a handle or knob that feels different to the touch than the other switches, or be physically isolated from them.

5.6.7 Patient Compartment Controls—The specified patient compartment controls, switches, and instruments shall be panel-mounted and located (unless otherwise specified) within normal reach to the immediate right of a seated EMT facing the rear of the patient compartment forward of the primary patient's head.

5.6.8 Marking of Switches, Indicators, and Control Devices—All switches, indicators, and control devices supplied by the vehicle manufacturer of the ambulance shall be

clearly visible to the ambulance personnel. They shall be perceptively and permanently identified with at least 12-point letters for the noun or function and 8-point for the remainder of the legend. The identifications shall be contrasting colors etched or engraved in plastic or metal, grouped according to function, mounted in illuminated or backlit panel(s) or console.

5.6.9 Electromagnetic Radiation and Suppression—In addition to OEM chassis, all electrically operated or electrical generating devices, including alternators, air conditioning, and warning light systems shall be electromagnetic radiation suppressed, filtered, or shielded to prevent interference to radios and telemetry equipment aboard the vehicle and the surrounding area. Electrically operated medical equipment furnished shall comply to MIL-STD-461 category Ale Portable Medical Equipment Carried Aboard Aircraft; certification of compliance shall be provided by an independent test laboratory.

5.7 Lighting, Ambulance Exterior and Interior:

5.7.1 Ambulance Exterior Lighting—The basic exterior ambulance lighting shall comply to FMVSS Std. No. 108, and the requirements herein, and shall include amber colored front and rear directional signals and hazard warning lights (except on Type II ambulances, if amber lenses are not available from OEM). The lower front and rear side marker lights shall flash in conjunction with the directional signals. Backup light(s)/loading light(s); clearance lamps when applicable; ambulance emergency lights, (see 5.7.2); floodlights, (see 5.7.3); and spotlight(s) (see 5.7.4) shall be furnished as specified.

5.7.2 Ambulance Emergency Lighting—The emergency lighting system must provide the vehicle 360° of conspicuity for safety during its missions. The system must 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 "Vehicle stopped on the right-of-way." Operation of the system shall be by a single switch with an illuminated indicator to show the mode of system. Additional generating capacity must be provided for any warning light load in excess of 35 A. All warning lights must conform to the requirements of SAE 595 or SAE J845 (Class 1), or SAE J1318 (Class 1) as well as the photometric requirements contained in Tables 1, 2, 3, and 4. Unless otherwise specified, the warning light color shall be red except for a clear front signal in the primary mode. The upper level of emergency lights shall be mounted at least 5 ft from the ground. In

TABLE 1 Flash Energy Requirements of Upper Level Red Warning Lights

Primary Mode Location Around the Ambulance	Minimum Flash Energy
Directly to the front of the ambulance	160 cd s
From directly ahead to 45° right and 45° left of front center	a gradual gradient of flash energy from 160 cd s to 45 cd s at 45° right and left of front center
From 45° right of front center around the rear of the vehicle to 45° left of front center	45 cd s
At $\pm 5^\circ$ from the horizontal plane of each warning light at each of the above locations	10 % of the above values



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