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Standard Specification for Medical Oxygen Delivery Systems for EMS Ground Vehicles[1]

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INTRODUCTION

Within the United States, there are several widely recognized national and international standards organizations that have established standards and guidelines for oxygen delivery systems. These standards and guidelines were largely developed for intrafacility use. This standard, developed by ASTM Subcommittee F30.01, addresses the requirements for oxygen systems, both liquid and gaseous, for emergency medical services (EMS) ground vehicles.

1. Scope

1.1 This standard covers minimum requirements for primary medical oxygen delivery systems for EMS ground vehicles used in the following applications:

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

1.1.2 The delivery of interhospital critical transport care,

1.1.3 The delivery of nonemergency, medically required transport services, and

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

1.2 This standard establishes criteria to be considered in the performance, specification, purchase, and acceptance testing of ground vehicles for EMS use.

1.3 This entire standard should be read before ordering an ambulance in order to be knowledgeable of the types of equipment that are available and their performance requirements. 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.

1.4 The sections in this standard appear in the following sequence:

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 The following documents, of the issue currently in effect, form a part of this standard to the extent specified herein.

2.2 *ASTM Standards:*[2]

F1177 Terminology Relating to Emergency Medical Services (Withdrawn 2018)[3]

2.3 *Military Standards:*[4]

MIL-STD-461 Requirements for the Control of Electromagnetic Interference Emissions and Susceptibility

[1] This specification is under the jurisdiction of ASTM Committee F30 on Emergency Medical Services and is the direct responsibility of Subcommittee F30.01 on EMS Equipment.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from Standardization Document Order Desk, 700 Robbins Ave., Building #4, Section D, Philadelphia, PA 19111-5094.

MS 33584 Standard Dimensions for Flared Tubing End
MS 33611 End Bend Radii

2.4 *Federal Specifications:*[4]
RR-C-901 Cylinders, Compressed Gas: High Pressure, Steel DOT3AA, and Aluminum Applications, General Specification for

2.5 *ASME Standard:*[5]
B31.3 Chemical Plant and Petroleum Refinery Piping

2.6 *CGA Standards:*[6]
E-7 Standard for Medical Gas Regulators and Flowmeters
V-1 Compressed Gas Cylinder Valve Outlet and Inlet Connections
S-1.1 Pressure Relief Device Standards Part 1—Cylinders for Compressed Gases

3. Terminology

3.1 *Definitions*—Specific terms used throughout this specification are defined in 3.2. Other applicable terms are contained in Terminology F1177.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *design operating pressure, n*—the nominal pressure at which the oxygen equipment or container is designed to operate during normal use.

3.2.2 *LOX container, n*—a vessel used to store or transport liquid oxygen.

3.2.3 *maximum allowable working pressure, n*—the maximum gauge pressure to which the equipment or container can be subjected without exceeding the allowable design stress.

3.2.4 *maximum filling volume, n*—the maximum filling volume of liquid at its maximum permissible level.

3.2.5 *pressure relief device, n*—a device designed to open in order to prevent a rise of internal fluid pressure in excess of a specified value.

3.3 *Symbols:*

3.3.1 *g*—the normal or standard constant of gravity at sea level; approximately 32.2 ft/s/s (9.81 m/s/s).

3.4 *Acronyms:*

3.4.1 *GOX, n*—gaseous oxygen.

3.4.2 *LOX, n*—liquid oxygen.

4. Significance and Use

4.1 The intent of this standard is to establish minimum requirements, test parameters, and other criteria essential for oxygen system design, performance, and appearance, and to provide for a practical degree of standardization. The object is to provide oxygen systems that are properly constructed and which, when properly serviced and maintained, will reliably function on an EMS ground vehicle.

5. Design Requirements

5.1 The medical oxygen delivery system may be either a gaseous oxygen (GOX) system or a liquid oxygen (LOX) system.

5.2 The oxygen delivery system shall be a piped oxygen system designed and installed as follows:

5.2.1 *Capacity*—The oxygen system shall be capable of storing and supplying a minimum of 3000 L of gaseous medical oxygen.

5.2.2 *Components*—All oxygen delivery system components shall be approved by the manufacturer of the component for the intended service. The system shall include the following:

5.2.2.1 *Oxygen Piping System,* designed and sized to deliver the required flow rates at the utilization pressures. Piping and tubing shall be of non-ferrous or corrosion-resistant steel material and shall comply with the design requirements of ASME B31.3. Hose shall be electrically conductive and approved by the manufacturer for oxygen service at the pressure and temperatures the hose will be subjected to in service. Fittings shall be of non-ferrous or corrosion-resistant steel material and shall comply with the design requirements of ASME B31.3. Cast fittings shall not be used.

5.2.2.2 *Flow Control Device,* of a pressure-compensated type that includes a means to display and monitor delivered flow rate. It shall be continuously adjustable over a minimum range of 0 to 15 L/min, with a calibrated display resolution of at least 0.5 L/min. The flow control device shall be calibrated for 50 psig inlet pressure and be able to withstand a minimum inlet pressure of 200 psig without damage or failure. It shall incorporate an inlet filter and be electrically conductive from inlet to outlet. Flow control device accuracy shall be within ±10 % of the indicated flow, or 0.25 L, whichever is greater.

5.2.2.3 *Oxygen Outlet,* piped to a self-sealing duplex oxygen outlet station. One of the outlets shall be for a flow control device or humidifier and the second oxygen outlet shall be for gas-specific, noninterchangeable, quick disconnect plug-in devices not requiring humidification. Outlets shall be marked and identified in accordance with CGA E-7.

5.2.2.4 *Shutoff Valve,* when specified, furnished in the 50-psig line and controlled and identified from the EMT panel. If a solenoid valve is utilized, a readily accessible emergency bypass valve shall be furnished and identified.

5.2.2.5 *Secondary Oxygen Outlet,* when specified, of the self-sealing, duplex wall outlet type. Additional outlets may also be specified. The outlets shall be marked and identified in accordance with CGA E-7 (see 6.1).

5.2.3 *Oxygen Compartment*—The oxygen compartment shall be provided with at least a 9-in.^{2} cover device which will dissipate or vent, leaking oxygen to the outside of the vehicle. The oxygen compartment shall not be utilized for the storage of any other equipment. No wiring or components shall terminate in the oxygen compartment except for the oxygen control solenoid, compartment light, switch plunger or trigger device, or other equipment that is integral to the oxygen system. Wiring passing through the oxygen compartment shall be routed in a metallic conduit.

[5] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, http://www.asme.org.

[6] Available from Compressed Gas Association (CGA), 4221 Walney Rd., 5th Floor, Chantilly, VA 20151-2923, http://www.cganet.com.

6. Performance Requirements

6.1 *Delivery Flow Rate*—The oxygen system shall be capable of delivering a minimum continuous gas flow of 100 L/min of gaseous oxygen, per patient, simultaneously, down to the 10 % tank content level.

6.2 *Delivery Pressure*—The oxygen system shall provide a delivery pressure of 50 ± 5 psig, at the specified flow rate at each medical oxygen gas outlet.

6.3 *Delivery Temperature*—The temperature of the gaseous oxygen supplied from each medical oxygen gas outlet shall be within +10 or –20 °F (+6 or –11 °C) of ambient temperature when the oxygen delivery system is subjected to the continuous flow described in 7.1.

6.4 *Temperature Conditions:*

6.4.1 *Storage Temperatures*—The oxygen system, when serviced and maintained in accordance with the manufacturer's recommendations, shall be capable of being stored without damage or deterioration in ambient temperatures of –30 °F (–34 °C) to 125 °F (52 °C).

6.4.2 *Cold Soak*—The oxygen system shall operate at a temperature of 0 °F (–18 °C) after being cold soaked for 6 h at –30 °F (–34 °C) followed by a 1 h cold soak at 0 °F (–18 °C).

6.4.3 *Heat Soak*—The oxygen system shall operate at a temperature of 110 °F (43 °C) after being heat soaked for 6 h at 125 °F (52 °C) followed by a 1 h heat soak at 100 °F (43 °C).

6.5 *Electromagnetic Interference*—Electrical or electronic componentry, or both, of the oxygen system shall meet the electromagnetic interference emissions and susceptibility requirements of MIL-STD-461 for ground vehicles.

6.6 *Structural Integrity*—Each oxygen system component, when mounted by its normal means of attachment and fitted with the equipment item(s) that are normally attached to it, shall have the structural integrity to withstand the vibration, acceleration, and shock environments described in 6.6.1 – 6.6.3.2. Pneumatic components may be non-operating but shall be pressurized to their maximum allowable working pressure when subjected to these environments. Electrical components may be non-operating but shall be "powered-up" when subjected to these environments. The vibration, acceleration, and shock environments shall produce no out-of-specification performance degradation or malfunctions except those allowed in 6.6.3.2.

6.6.1 *Vibration*—The component shall withstand sinusoidal vibration applied along each of three mutually perpendicular axes with the frequency range varying from 5 to 200 Hz with an amplitude of 1.0 in. from 5 to 5.5 Hz and an applied acceleration of 1.5 *g* from 5.5 to 200 Hz. The duration of applied vibration shall be 5.5 h per axis (a total time of 16.5 h). The frequency of applied vibration shall be swept over the specified range logarithmically with a sweep time of 12 min. The sweep time is that of an ascending plus a descending sweep.

6.6.2 *Acceleration*—The component shall withstand steady-state acceleration loads applied along three mutually perpendicular axes in two opposite directions along each axis. The duration of applied acceleration in each direction shall be at least 1 min. The applied acceleration levels shall be 4 *g* laterally in all four directions, 9 *g* vertically downward, and 3 *g* vertically upward.

6.6.3 *Shock*—The component shall withstand the basic design and crash worthiness shock loads defined in 6.6.3.1 and 6.6.3.2. The applied shock pulse shall be of the amplitude specified, a half-sine wave configuration, and 11 ms duration.

6.6.3.1 *Basic Design Shock Load*—The component shall withstand three shocks in each direction along three mutually perpendicular axes of the container (a total of 18 shocks). The peak value of the shock loads shall be 20 *g*.

6.6.3.2 *Crash Worthiness Shock Load*—The component shall withstand two shocks in each direction along three mutually perpendicular axes (a total of twelve shocks). The peak value of the shock loads shall be 60 *g*. The crash worthiness shock loads shall produce no failure of the mounting attachments. The component shall not break free from its mounting provisions or otherwise create a hazard. Permanent bending and distortion shall be permitted. The component need not be functional following application of the crash worthiness shock loads.

7. Installation Requirements

7.1 The installation of the oxygen system shall be in accordance with the following requirements:

7.1.1 *Oxygen Piping*—Oxygen piping shall be concealed and not exposed to the elements. The piping shall be accessible for inspection and replacement.

7.1.1.1 *Piping Routing and Mounting*—In routing the piping, the general policy shall be to keep total length to a minimum. Allowances shall be made for expansion, contraction, vibration, and component replacement. All piping shall be mounted to prevent vibration and chafing. This shall be accomplished by the proper use of rubberized or cushion clips installed at no greater than 20-in. intervals as close to the bends as possible. The piping, where passing through or supported by the vehicle structure, shall have adequate protection against chafing by the use of flexible grommets. The piping shall not strike against the vehicle during vibration and shock encountered during normal use of the vehicle.

7.1.1.2 *Flaring and Bending*—Tubing shall be single flared to conform with MS 33584. As an alternative, tubing may be welded, brazed, or swaged using methods and quality controls that produce leakproof joints, provided there is no undue degradation of tubing strength, corrosion resistance, or fatigue life. Tubing systems having these permanent type of joints shall be designed for ease of fabrication, inspection, and installation in the vehicle. The system layout shall provide for rapid in-service repair and component replacement. Tubing bends shall be uniform, without kinks, and fit the span between fittings without tension. The minimum bend radius to tube center lines shall be in accordance with MS 33611.

7.1.2 *Flow Control Device*—Flow control devices shall be installed so that they are readable from the EMT seat and squad bench. Flow meters shall be installed vertically.

7.1.3 *Oxygen Outlet Stations*—Oxygen outlet stations shall be provided with sufficient vertical space to permit connection of a humidifier or nebulizer, or both, directly to the oxygen flow control device.