AEROSPACE STANDARD

AS1046™ REV. C

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Superseding AS1046B

(R) Minimum Standard for Portable Gaseous, Oxygen Equipment

RATIONALE

AS1046C has been reaffirmed to comply with the SAE Five-Year Review policy.

1. SCOPE

This standard is intended to apply to portable compressed gaseous oxygen equipment. When properly configured, this equipment is used either for the administration of supplemental oxygen, first aid oxygen or smoke protection to one or more occupants of either private or commercial transport aircraft.

This standard is applicable to the following types of portable oxygen equipment:

a. Continuous flow

    1. Pre-set

    2. Adjustable

    3. Automatic

b. Demand flow

    1. Straight-demand

    2. Diluter-demand

    3. Pressure-demand

c. Combination continuous flow and demand flow.

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1.1 Purpose

This standard defines the general minimum performance standards for the design specifications; testing and packaging of portable oxygen breathing equipment, incorporating an integral compressed gas oxygen supply (refer to AS1303 for Portable Chemical Oxygen).

NOTE: This document does not contain specific information on the safe handling of Portable Oxygen Equipment containing a Compressed Gas container. Unsafe handling or stowage of such equipment could lead to tragic consequences especially during turbulence or other disruptive in-flight conditions. Airline operators should refer to the Compressed Gas Association (CGA) pamphlet P-1, "Safe Handling of Compressed gases in Containers" available from CGA, 1221 Walney Road, 5th Floor, Chantilly, VA 20151. Airline operators should include such safe handling procedures as part of their initial and recurrent training programs for cabin crew and maintenance personnel, and develop programs to ensure safe handling practices by passengers carrying and using such equipment on board their airplanes.

2. REFERENCES

The requirements set forth in AS861 shall be considered as part of this standard, except that in event of conflict, this standard shall take precedence.

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AIR825	Oxygen Equipment for Aircraft
AS861	Minimum General Standards for Oxygen Systems
AS916	Oxygen Flow Indicators
AIR1059	Transfilling & Maintenance of Oxygen Cylinders
AS1065	Quality and Serviceability Requirements for Aircraft Cylinder Assemblies
ARP1176	Oxygen System and Component Cleaning and Packaging
AS1219	Aircraft Oxygen Replenishment Coupling for Civil Transport Aircraft
AS1224	Continuous Flow General Aviation Oxygen Masks
AS1248	Minimum Standard for Oxygen Pressure Reducers
AS1303	Portable Chemical Oxygen
AS8010	Aviators Breathing Oxygen Purity Standard
AS8025	Passenger Oxygen Mask

AS8026 Crewmember Oxygen Demand Mask for Transport Category Aircraft

AS71051 Pipe Threads, Taper, Aeronautical National Form, Symbol ANPT

2.1.2 Other References

A-A-59503 Nitrogen, Technical

BB-A-1034 Compressed Air

MIL-S-7742 Screw Threads Standard, Aeronautical

MIL-PRF-27210 Oxygen, Aviator's Breathing, Liquid and Gas

A-A-58092 Tape, Antiseize, Tetrafluoroethylene, with Dispenser

FAR PART 21 Certification Procedures for Products and Parts, 14 CFR Part 21

FAR PART 25 Airworthiness Standards Transport Category Airplanes, 14 CFR Part 25

FAR PART 23 Airworthiness Standards Normal, Utility and Acrobatic, 14 CFR Part 23

FED-STD-595 Federal Standard Colors

ATA Spec 2000

CGA S-1.1 Pressure Relief Device Standards - Part 1 Compression Gas Association

CGA P-1 Safe Handling of Compressed Gases in Containers

TARIFF BOE 6000 Hazardous Materials Regulations of the Department of Transportation (DOT) 49 CFR 170

TSO-C64a Oxygen Mask Assembly, Continuous Flow, Passenger

TSO-C89 Oxygen Regulators, Demand

TSO-C99 Protective Breathing Equipment

2.2 Definitions

NTPD: Normal temperature and Pressure, Dry; (at 21 °C (70 °F), 760 mm Hg (0.101325 MPa) and $pH_2O = 0$).

BTPS: Body Temperature, Pressure, Saturated; (37 °C (98.6 °F), ambient pressure, saturated with water vapor at 37 °C pH_2O at 37 °C = 47 mm Hg (6.27 kPa)).

STRAIGHT-DEMAND REGULATOR: A regulator that supplies gas when subjected to a slightly negative pressure as a result of each inspiration; the flow normally ceasing on exhalation.

DILUTER-DEMAND REGULATOR: A regulator with a device for diluting the oxygen with air. This device is usually an aneroid controlled valve that decreases the air added to the oxygen automatically as altitude increases.

PRESSURE-DEMAND REGULATOR: A regulator which by virtue of either mechanical or pneumatic loading of the sensing diaphragm or element, delivers gas at a slightly positive pressure during each inspiration, and maintains a positive pressure, with no oxygen delivery, during expiration.

CONTINUOUS FLOW PRE-SET REGULATOR: A regulator that delivers a defined quantity of oxygen at a constant flow typically through a fixed orifice calibrated to provide a minimum desired flow at a specific altitude. The flow will vary with altitude due to the change in differential pressure across the orifice.

CONTINUOUS FLOW ADJUSTABLE REGULATOR: A regulator that delivers a defined quantity of oxygen at a constant flow and is adjustable manually to vary the flow and to provide a minimum desired flow at a specific altitude. The regulator will have a means to identify the flow or altitude setting for which the provided flow is suitable.

CONTINUOUS FLOW AUTOMATIC REGULATOR: A regulator that delivers a defined quantity of oxygen at a constant flow which will vary automatically with altitude changes to provide a minimum desired flow at a specific altitude. The automatic control of the flow will typically be through an aneroid control.

AVERAGE RATED DURATION: For demand and pressure-demand units the duration shall be based on a minute volume of 20 L (dm^3) BTPS and 100% oxygen supplied. For diluter-demand units an average oxygen-air mixing ratio for the altitude under consideration shall be used with a minute volume of 20 L (dm^3) BTPS. For all unit types consider use by one person at its rated altitude and a full cylinder. By nature, demand systems vary greatly in oxygen usage because of variations in individual user's actual vital capacity, rate of exercise, etc. Therefore, the above-rated duration should be considered only an average.

DURABLE MARKING: A marking on a unit or component intended to provide information about the unit or for identification purposes. The marking shall remain legible through normal usage and handling during the period of time between normal service intervals at which time it could be refreshed.

3. REQUIREMENTS

3.1 Detail Requirements

Each portable unit shall consist of the following basic components as noted:

a. Oxygen cylinder

b. Oxygen pressure reducer and/or continuous flow regulator with necessary accessories

c. Personal oxygen dispensing unit (such as mask(s) or facepieces)

d. Flow indication (optional for demand flow units alone or as part of combination units)

e. Carry means or harness (optional)

e. Overall container (optional)

3.2 Oxygen Cylinder

The oxygen cylinder shall conform to Department of Transportation (DOT) Specifications 3A or 3AA or to any other DOT specifications for transportable cylinders for oxygen service. Local regulations including any applicable nation's requirements may also apply. The cylinder shall be permanently marked to show the applicable DOT or local specification number, service pressure and most recent test date. Prior to assembling components to the cylinder, it shall be cleaned to those levels specified in ARP1176.

3.2.1 Filling Pressure

The filling pressure shall be prominently shown for the benefit of the user by a durable marking and the pressure shall not exceed the Original cylinder manufacturers service pressure rating stamped near the neck of a steel cylinder or permanently affixed to the cylinder as required by applicable regulation. For example, a cylinder manufactured to specification DOT 3AA 1800 will be marked "MAX. PRESSURE 1800 PSIG @ 70 °F (13.65 MPa @ 21.1 °C)". If the cylinder meets the requirements for 10% overcharging as indicated by a plus sign (+) following the test date marking on the cylinder, this shall be shown on the stencil or other marking. For example, a "+" cylinder manufactured to specification DOT 3AA 1800 will be marked "MAX. PRESSURE 1980 PSIG @ 70 °F (13.65 MPa @ 21.1 °C) with "+" marking". This is equivalent to the noted service pressure x 110%.

3.2.1.1 Gas

The cylinder shall be filled with aviator's breathing oxygen conforming to MIL-PRF-27210 or AS8010.

3.2.2 Capacity and Shape

The capacity and shape of the cylinder shall be as required by, or acceptable to, the purchaser.

3.2.2.1 Protrusions

External tubing or other provisions that might be used as carrying or supporting handles must be designed to safely withstand the loads which might be imposed on them.

3.2.3 Capacity

The gaseous volume of oxygen in liters (dm^3) NTPD, contained in the cylinder when charged to its rated pressure shall be indicated on the cylinder by a durable marking. For example, an acceptable marking is "CONTAINS XXXX LITERS, NTPD, WHEN CHARGED TO XXXX PSIG", or "CONTAINS XXXX dm^3 NTPD, WHEN CHARGED TO XXXX MPa".

3.2.4 Duration

For demand flow units, the rated altitude and the average rated duration, when used at its rated altitude by one person, of the supply of oxygen in the cylinder when filled to its rated pressure shall be indicated by a durable marking.

3.2.5 Color

Color of the cylinder shall be optional with the purchaser. Unless otherwise specified, cylinders shall be green in color.

The cylinder shall be prominently and durably marked "AVIATOR'S BREATHING OXYGEN".

3.2.6 Cylinder-to-Regulator Attachment

The attachment of the regulator, valve, or other component to the oxygen cylinder may be by one of the following:

a. Taper pipe threads conforming to AS71051 and using as a thread anti-seize, Teflon® tape conforming to A-A-58092.

b. Straight threads conforming to MIL-S-7742 with a gasket seal; the gasket material shall be compatible for use with high-pressure oxygen.

3.3 Regulator

The regulator shall control the delivery of oxygen to the user(s) either through a continuous-flow metering device, through a demand regulator, or both. The following functions shall be deemed a part of the regulator, although they may not all be integral portions of a single unit, but may be arranged as separate components interconnected.

a. ON-OFF mechanism to control the delivery of the cylinder oxygen gas supply from the unit.

b. Cylinder contents indicator (pressure gage).

c. High pressure safety relief device.

d. Regulated or low pressure relief valve mechanism.

e. Filler fitting or a means to replace the compressed gas in the cylinder.

f. One or more continuous-flow outlets and/or a demand type regulator.

3.3.1 Regulator Performance

All units must meet minimum flow requirements at all usable outlets, continuous flow and demand when used at the same time.

3.3.1.1 Pre-Set Continuous-Flow Type

Unless otherwise specified by the purchaser, the mass flow of oxygen from each outlet shall be such that when used in combination with the mask recommended by the manufacturer (or selected by the user), the combination will deliver to the user sufficient oxygen to maintain the minimum tracheal oxygen partial pressure or mass flow rate specified in the appropriate paragraph(s) of FAR Part 25.1443, or FAR Part 23.1443, at the altitude(s) stipulated by the manufacturer. The highest altitude at which this requirement is met shall be clearly indicated by a durable marking.

3.3.1.2 Adjustable Continuous Flow Type

The regulator may be provided with a means for varying the flow of oxygen either by adjustment of the regulator, adjustment of the constant flow outlet, or other means. When such adjustment is provided, its use and limitations of use shall be clearly explained in a durable marking. Unless otherwise specified by the purchaser, the flow of oxygen shall be adequate (when used in combination with the mask recommended by the manufacturer or selected by the user) to maintain a minimum tracheal oxygen partial pressures or mass flow rate specified in the appropriate paragraph(s) of FAR Part 25.1443, or FAR Part 23.1443 at the altitudes stipulated by the manufacturer.

3.3.1.3 Automatic Continuous Flow Type

The regulator shall be provided with an automatic mechanism that will vary the flow of oxygen in accordance with altitude. Its operation shall be clearly explained in a durable marking. Unless otherwise specified by the purchaser, the flow of oxygen shall be adequate (when used in combination with the mask recommended by the manufacturer or selected by the user) to maintain the minimum tracheal oxygen partial pressures specified in the appropriate paragraph(s) of FAR Part 25.1443, or FAR Part 23.1443 at the altitudes stipulated by the manufacturer.

3.3.1.4 Straight-Demand Type

When a demand regulator is included in the equipment, either alone or in combination with one or more continuous flow outlets, the demand regulator shall deliver oxygen from the regulator in response to the inspiratory effort (draft) of the user. The demand regulator shall meet the requirements of FAA TSO-C89.

3.3.1.5 Diluter-Demand Type

In response to the inspiratory effort of the user, the diluter-demand regulator shall deliver a mixture of air and oxygen. The concentration of oxygen in the mixture delivered to the mask shall be not less than that required to maintain a minimum tracheal partial pressure of oxygen of 122 m Hg (16.3 kPa) at inspiratory flow rates of 10 to 120 LPM-BTPS (dm^3/min) within the altitude range stipulated by the manufacturer. Where the equipment is to be used for passengers the tracheal partial pressures and flow rates must conform to FAR 25.1443(C). The altitude to which the regulator will perform this function shall be clearly indicated by means of a durable marking.

3.3.1.6 Pressure-Demand Type

The pressure-demand regulator shall deliver oxygen to the mask at a positive (above atmospheric) pressure at those altitudes or under other conditions where 100% oxygen is required. Such a pressure shall be sufficient to:

a. Provide protection against smoke during use by precluding inward mask leakage of the ambient atmosphere; and/or

b. Partially compensate for reduced barometric pressure at altitudes at which 100% oxygen at ambient atmospheric pressure is inadequate for physiological needs.

The pressure-demand regulator shall meet the requirements of FAA TSO-C89.

3.3.2 ON-OFF Mechanism

An ON-OFF mechanism shall be provided to control the delivery of oxygen from the cylinder. The mechanism or valve may be one of the following:

a. A high pressure valve between the cylinder and the pressure reducer/regulator

b. A pressure reducer/regulator mechanism designed to serve as both an ON-OFF valve and a regulating control

c. A low pressure valve on the downstream side of the pressure reducer

3.3.2.1 High Pressure Valve

When provided with this mechanism, the valve shall isolate the cylinder contents from all parts of the regulator except the cylinder contents gauge, the high pressure fill port and the high pressure safety relief device.

3.3.2.2 Valve-Regulator Combination

When provided with this mechanism, a means shall be provided for mechanically controlling the regulating valve for the purpose of either preventing flow from passing the regulating valve or allowing flow to pass through the regulator and allowing it to function simultaneously as a pressure reducer.

3.3.2.3 Low-Pressure Valve

When provided with this mechanism, a low pressure valve on the downstream side of the pressure reducing regulator shall, by stopping the discharge of gas, cause the pressure reducer valve to close and prevent further entry of gas from the cylinder to the outlets.

3.3.3 Valve Design, Construction, and Materials

The requirements and recommendations of AIR825/13 shall be considered in the design of valves. Valve seats, seals, or other nonmetallic materials shall be compatible for use with oxygen at the maximum working pressure and temperature anticipated (see also AS1248).

3.3.4 Valve Control

The valve control shall be clearly and durably marked to indicate the direction of movement to open or close the valve. The valve control may be of the rotating knob, rotating lever, or "push-pull" type. Rotating type controls shall operate with a torque not exceeding 1.7 Nm (15 in lb). "Push-Pull" type controls shall require not more than 44.5 N (10 lb) of force to either open or close the valve.

3.3.5 Cylinder Contents Indicator

The indicator shall at all times (regardless of whether the on-off valve is open or closed) indicate (in Pa or psi, unless otherwise specified by the customer) the pressure existing in the cylinder. If so specified by the customer, the indicator may show the maximum filling pressure and the pressure at which the cylinder should be refilled. The use of the color red in bands to signify fill levels should be avoided except to indicate an unacceptable level of fill.

3.3.6 High Pressure Safety Device

The safety device shall be of a type approved by the Bureau of Explosives or an applicable nation's requirements and shall comply with the requirements of CGA Pamphlet S-1.1. It shall serve to release the contents of the cylinder within the pressure range designated by DOT regulations as part of 49 CFR Hazardous Materials Regulations or an applicable nation's requirements. The outlet of the device shall be designed to minimize the propulsive effects of the escaping gas. It shall be safety wired where feasible.

3.3.7 Low Pressure Relief Mechanism

The low pressure relief mechanism shall release from the reduced pressure area of the regulator any pressure in excess of that which can be safely contained, or in excess of that which will permit safe performance of the regulator. The mechanism shall reclose after release of excess pressure.

3.3.8 Continuous Flow Oxygen Connection

The style and type of connection shall be optional with the purchaser. On connections used with a pre-set regulator, the connection shall be marked to indicate the oxygen flow rate and rated altitude. Color coding (or other equivalent means), explained by a durable decal or label, is acceptable. The connection shall be designed to permit easy coupling by a cabin attendant.

3.3.9 Filler Fitting

The equipment shall be provided with a fitting through which the oxygen cylinder can be refilled from a source of gaseous oxygen under adequate pressure. The fitting shall be in accordance with Item A of Figure 1. The filler fitting shall incorporate a filter of 125 µm nominal or better particle retention. The fitting shall be protected against damage or contamination by a removable cap or equivalent means. As an alternate, the filler fitting shall be in accordance with AS1219.

3.4 Flow Indicator (Reference AS916)

A means for flow indication shall be provided by the manufacturer. Flow indication may be accomplished by use of a compontent to indicate to the user that the oxygen is being delivered to the dispensing equipment. Alternatively, the purchaser, who may have specific operational procedures that make one method of indicating flow more appropriate for his application than another, may specify a test to indicate flow. The manufacturer shall verify that the purchaser-specified test meets existing requirements for the purpose of indicating flow.

3.5 Harness

When and as specified by the purchaser, the equipment may be provided with a harness whereby the equipment can either be conveniently carried or worn, either by a crew member or by a passenger using the equipment. When furnished with a shoulder strap, the equipment should also be provided with a waist belt or some type of restraint to minimize uncontrolled swinging of the unit when worn by an ambulatory crew member or passenger. Choice of material, color and design detail of the harness shall be at the option of the purchaser.

3.6 Overall Container

The equipment may be supplied in an overall enclosure or the container designed to allow one of the following:

a. The equipment can be used without removal from the container

b. The container acts as a protection and a means of stowing the equipment, and the equipment is readily accessible for use

The specific details of the container shall be optional with the purchaser unless controlled by regulation. A container that acts as a stowage container mounted to the aircraft shall meet the requirements of 14 CFR paragraph 25.787 or an applicable nation's requirements.

3.7 Personal Oxygen Dispensing Unit

3.7.1 Continuous Flow

The choice of a rebreathing type versus a non-rebreathing type shall be at the discretion of the purchaser using AS1224 or AS8025 as a guide to determining the altitude limits for the various types of constant flow masks. The personal oxygen dispensing unit, hose and connector shall be compatible with the equipment its intended to be used with and shall be readily available for use with the unit and adequately protected from abuse, damage, tampering and contamination. This paragraph is not intended to exclude respiratory devices other than masks, such as a head hood, provided that its performance is at least equivalent.

3.7.2 Demand and Pressure-Demand

Personal oxygen dispensing units shall conform to AS8026.

4. QUALITY ASSURANCE PROVISIONS

4.1 Classification and Scope

4.1.1 Qualification Testing

Qualification testing by the supplier shall consist of, but not necessarily be limited to, those tests in 4.3.1 through 4.3.7 and shall be documented. The supplier shall document and retain for reference all qualification testing.

4.1.2 Acceptance Testing

Acceptance tests shall be defined by specification and shall include at least the requirements in 4.3.1 through 4.3.3.

4.2 Test Media

The testing media shall be one of the following:

a. Oxygen per MIL-PRF-27210, Type 1, or AS8010.

b. Nitrogen per A-A-59503, equivalent in dryness and contamination levels to oxygen per MIL-PRF-27210, Type 1 or AS8010.

c. Air per BB-A-1034, equivalent in dryness and contamination levels to oxygen per MIL-PRF-27210, Type 1 or AS8010.

4.2.1 If other than oxygen is used in testing, appropriate correction factors must be applied where necessary; that is, in flow requirements.

4.2.2 If other than oxygen is used in testing, manufacturer must clear or vent the unit of the test gas and the unit or component must be purged with oxygen. If the unit is to be filled prior to shipping, insure that oxygen per MIL-PRF-27210, Type 1 or AS8010 is used.

4.3 Test Methods

All testing shall be conducted at temperatures of 25 °C ± 10 °C (77 °F ± 18 °F) unless otherwise specified.

4.3.1 Product Examination

The unit shall be carefully examined to determine conformance to applicable specification with respect to materials, workmanship, finish, dimensions, markings, and cleanliness for oxygen service.