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AEROSPACE STANDARD

AS 1224A

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CONTINUOUS FLOW AVIATION OXYGEN MASKS
(For Non-Transport Category Aircraft)

1. SCOPE

1.1 Purpose: This standard defines the minimum requirement for the design, construction and performance of continuous flow oxygen masks for crew and passengers of general aviation civil aircraft.

1.2 Types: This standard includes the following types of continuous flow oxygen masks.

a. Open port dilution rebreathing masks.
b. Valved or restrictive phase dilution rebreathing masks.
c. Valved or restrictive phase dilution reservoir masks.
d. Open port or restrictive dilution mask without rebreathing or reservoir bag.

1.3 Description: The masks shall be of an oronasal type covering the nose and mouth, utilizing a continuous supply of oxygen and consisting of the facepiece, valving, mask suspension device, rebreathing or reservoir bag (except Type "d"), supply tube, and including connector and flow indicator (when used).

1.4 Definition: The mask types are defined as follows:

a. Open port dilution rebreathing mask - This is a type of mask incorporating a rebreather bag into which exhaled gases, high in oxygen content from the first portion of the previous exhalation, are introduced to be inspired again upon the next inspiration. Dilution of oxygen flowing into the mask is accomplished by fixed nonvariable orifices incorporated in the body of the mask or system, allowing dilution by introduction of ambient air during inspiration. Valving is not present between the mask facepiece and rebreathing bag.

b. Valved or restrictive phase dilution rebreathing mask - This type of mask may be either of the following:

(1) A mask utilizing a rebreather bag into which a constant flow of oxygen is introduced. A check valve between the mask and ambient air is provided so that the ambient air will not be admitted before the rebreather bag has been depleted. Valving is not present between the mask facepiece and the rebreather bag, or

(2) A mask utilizing a rebreathing bag but incorporating a restrictive sponge or other means which admits dilution air when subjected to a significant decrease in intra-mask pressure. Valving is not present between the mask facepiece and rebreather bag.

c. Valved or restrictive phase-dilution reservoir mask - This type of mask provides the most efficient physiological use of constant-flow aircraft oxygen and may be one of the following:

(1) A mask utilizing a reservoir bag incorporating a check valve between the mask facepiece and reservoir bag to prevent introduction of exhaled gases into the reservoir bag and to assure 100% oxygen in the reservoir. Dilution is accomplished at the later phases of inspiration by a loaded ambient air valve which introduces ambient air following depletion of the 100% oxygen content of the reservoir bag, or

(2) A phase-dilution mask utilizing a reservoir bag with valve between the bag and the mask. A porous restrictive dilution port to provide inhalation of ambient air at a slower rate than oxygen from the reservoir, furthermore permitting the exhaled air to leave the mask.

d. Open-port or restrictive-dilution mask without rebreathing or reservoir bag - This mask is defined as a mask which incorporates dilution ports or restrictive dilution such as by the use of open-cell foam construction or one or more air inlet valves. This mask is not recommended for efficient physiological use of the aircraft oxygen, commensurate with requirements for pilot safety or survival in hypoxic environments at altitude.

2. MATERIALS

2.1 General: Materials shall be of type, grade and quality which experience and/or tests have shown to be suitable for the purpose intended. Materials shall not be used which contaminate oxygen or are adversely affected by continuous service with oxygen. Materials shall have at least flame resistant porperties as defined in the Federal Aviation Regulations Part 1, Paragraph 1.1.

2.1.1 Facepiece: The facepiece shall be free of objectionable odors. Materials in contact with the skin shall be selected to be as non-irritating, non-allergenic, soft and compliant to the facial configuration as practical.

2.1.2 Cleaning and Sterilizing: The mask shall be made of materials which will permit cleaning and sterilization without adverse effects and without disassembly. The method of cleaning and sterilizing shall be recommended by the manufacturer.

2.1.3 Elastomer Components: A tag or leaflet describing elastomeric components with service life limits and a suggested method for inspection and detection of any deterioration in these components which may adversely affect the performance of the mask shall be attached to or included in the packaged mask prior to delivery to the user.

2.1.4 Fungus: Components shall be fungus-proofed by selection of parts and materials that are non-nutrient to fungus, or by treatment of the parts and materials prior to their use.

2.1.5 Dissimilar Metals: Unless suitably protected against electrolytic corrosion, dissimilar metals shall not be used in intimate contact with each other.

3. WORKMANSHIP

3.1 General: The mask shall be fabricated and finished in accordance with the highest grade practice in the manufacture of this type of equipment. The finished mask and all internal parts shall be clean throughout and free of fins, burrs, scale, oils, materials or any other conditions which might adversely affect the safe operation of the mask.

3.2 Finish: All materials which are not inherently corrosion-resistant shall be finished with a protective treatment or coating to minimize the effect of exposure to the environmental conditions which may be encountered in the service for which the equipment is intended. The protective treatment or coating shall not chip, flake, or powder, or otherwise contaminate the mask.

3.3 Strength: The rebreather bag, reservoir bag, oxygen supply tube, and facepiece shall be assembled in such a manner that when supported at the inlet end of the supply inlet, the assembly shall support a static load of 20 lb (90 N), applied at the facepiece for a period of 3 sec after having been subjected to the environmental conditions as specified in 3.4.1.1.

All components of the mask assembly shall be resistant to tears, snags, embrittlement and cracking, and all other defects leading to malfunction of the article, which might be caused by normal handling during the service life.

3.3.1 Rebreather or Reservoir Bag (when used): The rebreather or reservoir bag shall be easily removed and replaced, but should be so designed that it may not be inadvertently detached while in use.

3.3.1.1 Bag Strength: The rebreather or reservoir bag shall be capable of withstanding 2 psi (13.8 kPa) pressure for 3 sec without failure or damage and constructed of a pliable material to preclude compromise of valve sequencing and the oxygen/dilution cycle of rebreathing and phase dilution masks. ø

3.3.1.2 Bag Assembly: The bag, when used, shall be attached to the facepiece and tubing with sufficient strength to withstand a pull force on the bag in any direction of 5 lb (22.2 N) for 3 sec and made of flexible material which will collapse when not in use. The bags shall have the following minimum and maximum capacities when inflated to 0.5 in. H_2O (124 Pa) positive pressure: ø

Type	Minimum Volume (cm^3)	Maximum Volume (cm^3)
Rebreather	800	1,000
Reservoir	1,000	1,500

3.3.2 Facepiece Assembly:

3.3.2.1 Fit: The facepiece shall be of sufficient resilience, size, and shape to conform readily to facial contours using no more pressure than supplied by the mask suspension device. Mask design should consider extremes of Nasion-Menton, Bizygomatic, Bigonial, and Nasion-Supramentale distances and other applicable anthropometric information required to provide an adequate fit. Suggested sources of information include:

Adults: An Anthropometric Sizing Program for Oral-Nasal Oxygen Masks Based on 1967 U.S. Air Force Survey Data, AMRL Technical Report 75-51, McConville and Alexander.

Anthropometry of Air Force Women, AMRL Technical Report 70-5, April 1972, C. E. Clauser, et al.

Anthropometric Sizing and Fit-Test of the MC-1 Oral-Nasal Oxygen Mask, WADC Technical Report 58-505, March 1959, Emanuel, Alexander, and Churchill.

Recommended Subject Selection and Test Procedure for Quantitative Respirator Testing, J. T. McConville, E. Churchill and A. Hack, Health, Education & Welfare Contract HSM-99-75-15, Nov. 30, 1973.

Anthropometery for Respirator Sizing, J. T. McConville, E. Churchill, and L. L. Lauback, Health, Education & Welfare Contract No. HSM-099-71-11, April 30, 1972.

Children: Selected Facial Measurements of Children for Oxygen Mask Design, J. W. Young, FAA, Office of Aviation Medicine, Civil Aeromedical Institute, Report AM 66-9, April 1966, Okla. City, Okla.

3.3.2.2 Volume: The chamber formed between the face and the mask shall be so configured as to provide proper fit and adequate comfort with minimal deadspace which could contribute to carbon dioxide retention.

3.3.2.3 Resilience: The main body of the mask shall be resilient enough to minimize deformation due to stowage and incorrect handling, which might compromise operating performance.

3.3.2.4 Valve Design: When used, dilution valve cracking pressure and resistance must be related to oxygen inflow resistance in order to assure proper phasing of the oxygen/dilution cycle. Other valves, when used, shall be designed to offer the following maximum resistance:

Oxygen inflow valve: 0.8 in. H_2O (200 Pa) at 30 L/min. (.030 m^3/min.) NTPD*
2.0 in. H_2O (498 Pa) at 70 L/min. (0.70 m^3/min.) NTPD

Exhalation valve: 2.0 in. H_2O (498 Pa) at 85 L/min. (.085 m^3/min.) NTPD

3.3.2.5 Attachment of the Mask Suspension Device: Provisions shall be made on the facepiece for attaching a mask suspension device.

3.3.3 Mask Suspension Device: A simple mask suspension device shall be provided for holding the mask on the user's face. A simple means of adjusting the tightness of the mask to the face shall be provided.

3.3.4 Tubing: The oxygen supply tube which is to be used for connecting the mask assembly to the oxygen supply source shall be lightweight and adequate for its intended use. The tubing shall be fully flexible within a temperature range of -20°F (-29°C) to 160°F (71°C). The tubing shall be capable of being bent to a 1.0 in (2.54 cm) radius during stowage with less than 5% restriction to flow at 30 L/min. (.030 m^3/min.) NTPD upon being removed from stowage.

3.4 Performance Requirement:

3.4.1 Environmental Conditions:

3.4.1.1 Temperature and Humidity: The assembly shall be capable of being stowed at temperatures of 160°F (71°C) for 120 hr and -67°F (-55°C) for 2 hr, at relative humidities varying from 5% to 95%, without affecting subsequent performance after return to normal temperature of 70°F (21°C) for 30 minutes.

3.4.1.2 Condensation: Operation of the equipment shall not be adversely affected by moisture accumulated during use.

3.4.1.3 Vibration: The mask assembly shall be capable of performing adequately after exposure to one million cycles, or 8 hr, of vibration at the resonant frequency or frequencies as determined by a scan of vibration frequencies as plotted in Figure 1, NAS 1179, Feb. 1961. At each resonant frequency detected, the mask shall be exposed to one million cycles or 8 hr vibration at this frequency and amplitude, as shown in Figure 1, with the mask mounted: (a) with the direction of the vibration in line with the principal axis of the mask, and (b) in a direction perpendicular to the principal axis of the mask.

If no resonances are found with the frequency range of Figure 1, vibrate the mask at 100 cycles per sec (100 Hz) and the corresponding amplitude of Figure 1, for one million cycles in each direction.

*NTPD - Normal temperature (21°C, 70°F), normal pressure (760 mm Hg, 14.7 psi, 101 kPa), Dry.

3.4.1.4 Leakage Tests: Gas and supply tube leakage - with all openings to the mask facepiece sealed, apply a pressure of at least 2 in H_2O (498 Pa) to the supply tube inlet. The gas bag, including connections to the facepiece and supply tubing, shall not exhibit a leakage in excess of 10 cm^3 per min when pressurized to the above value.

4. MASK PERFORMANCE

4.1 Use: It is the intent of this standard that the mask assembly, as used by passengers and crewmembers of non-pressurized and pressurized general aviation aircraft, shall be capable of maintaining during inspiration a mean tracheal oxygen partial pressure of no less than 100 mm Hg (13.33 kPa) when engaged in flights not to exceed 35,000 ft (10,668 m). Constant-flow passenger masks which provide reliable concentrations approaching 100% oxygen shall be provided passengers of pressurized aircraft engaged in flights above 35,000 ft (10,668 m) and not to exceed 41,000 ft (12,497 m) for which a potential exists for pressurization failure and emergency cabin decompression to the flight altitude of the aircraft. These masks designs shall be capable of maintaining a mean tracheal oxygen partial pressure of no less than 83.8 mm Hg (11.17 kPa) during inspiration. It is recommended that constant-flow oxygen masks as detailed in this standard not be used by those individuals in control of pressurized or non-pressurized aircraft above an altitude of 35,000 ft (10,668 m). Oxygen requirements and masks for crewmembers controlling aircraft at higher altitudes are detailed in AIR 825A, AIR 1069, and AS 452A.

4.1.1 Altitude Limitations: It is recommended that constant-flow masks of the following types be limited to the following altitudes depending upon their use in pressurized or non-pressurized aircraft and whether they are to be worn by the passengers or by individuals in control of the aircraft. These altitude limitations are based on theoretical equipment capabilities and do not necessarily account for variations in the degree of training, physical activity, duration of exposure, general health, and/or altitude tolerance of the user.

a. Open port dilution rebreathing mask (passengers & crew).

1.	Pressurized	27,000 feet (8,230 m)
2.	Non-Pressurized	25,000 feet (7,620 m)

b. Valved or restrictive phase-dilution rebreathing masks (passengers & crew).

1.	Pressurized	35,000 feet (10,668 m)
2.	Non-Pressurized	30,000 feet (9,144 m)

c. Valved or restrictive phase-dilution reservoir masks (passengers).

1.	Pressurized	41,000 feet (12,497 m)
2.	Non-Pressurized	35,000 feet (10,668 m)
(crew)		
1.	Pressurized	35,000 feet (10,668 m)
2.	Non-Pressurized	35,000 feet (10,668 m)

d. Open port or restrictive phase-dilution mask without a rebreather or reservoir bag (passenger & crew).

1.	Pressurized	20,000 feet (6,996 m)
2.	Non-Pressurized	15,000 feet (4,572 m)

4.1.2 Performance Test "A": The performance of the mask shall be established by first determining a typical fit leakage value on representative randomly selected subjects, and then testing the mask on a breathing machine which can consistently produce the minute and tidal volumes specified. The typical fit leakage tests shall be carried out as specified in para. 4.1.7.1 of NAS 1179. In lieu of the leakage test method prescribed in NAS 1179, 4.1.7.1.1, the nitrogen dilution method (which is considered to be a more definitive leakage test) as detailed in the final report of FAA Contract No. FAA-885, Feb. 8, 1962, may be used. A suitable rapid response respiratory mass spectrograph capable of breath-by-breath analysis may also be utilized in determining mask leakage.

4.1.2.1 Breathing Machine Tests With Typical Fit Leakage: When using a breathing machine for test purposes, hermetically seal the facepiece of the test mask against the face of the breathing machine and incorporate a mechanism to provide the typical fit leakage. A suitable gas sampling orifice shall be provided in the portion of the breathing machine representing the trachea. The breathing machine shall have a simulated tracheal dead space of approximately 150 cm^3; and shall insure a thorough mixing of the gases in the simulated lung. The respiratory rate and tidal volume shall be sufficiently adjustable to meet requirements of this standard. The simulated respiratory flow shall essentially follow a pattern such as occurs in human respiration. An outline of a typical dynamic testing system for demand regulators which may be modified for constant-flow system testing is detailed in ARP 1109.

4.1.2.2 Tracheal Oxygen Partial Pressure Breathing Machine Test: For each representative mask tested the tracheal oxygen partial pressure shall be determined at 13.37 L/min. NTPD (15 L/min. BTPS*) and with a tidal volume of 623 cm^3 NTPD (700 cm^3 BTPS) and 26.7 L/min. NTPD (30 L/min. BTPS) with a tidal volume of 980 cm^3 NTPD (1100 cm^3 BTPS) using the minimum mass oxygen flow curve as specified in 23.1443 of the Federal Aviation Regulations (See Appendix 1). If the specified flows are not adequate to provide the tracheal oxygen partial pressures specified in 4.1 then the additional oxygen flow to provide these tracheal oxygen partial pressures at 5,000 ft (1,524 m) increments shall be recorded.

4.1.2.3 Inspired Carbon Dioxide Breathing Machine Test: The complete mask shall be tested by attaching and sealing the facepiece to a dummy head connected to a breathing machine which operates at a breathing rate of 20 cycles per min. with a displacement of 750 cm^3/cycle. Oxygen containing 5% CO_2 shall be exhaled into the facepiece. With oxygen flowing to the mask at the flow rate recommended by the manufacturer, the partial pressure of CO_2 in inspired air, measured at the mouth of the dummy's head, shall not exceed an average of 20 mm Hg (2.67 kPa) during the inspiratory portion of any cycle. (Ref.: Department of the Interior, Bureau of Mines, 4800 Forbes St., Pittsburgh, Pa. - Report Number RI-6865.

4.1.3 Performance Test "B" (human subjects at altitude): Human testing at altitude shall be performed as specified in 4.1.8 of NAS 1179 with the exception that only five subjects need be evaluated and exercise may be used to stimulate respiration to the desired minute and tidal volume in lieu of voluntary hyperventilation. The masks shall demonstrate a capability of providing a tracheal oxygen partial pressure of 100 mm Hg (13.33 kPa) at altitudes and flow rates specified in para. 23.1443 of the Federal Aviation Regulations (See Appendix 1), with the exception that masks designed for and used by passengers only may demonstrate a capability of providing a tracheal oxygen partial pressure of 83.8 mm Hg (11.17 kPa) above an altitude of 35,000 ft (10,668 m) up to and including 40,000 ft (12,192 m). If performance test "A" or "B" indicates the mask design is incapable of providing the specified tracheal oxygen partial pressures of 100 mm Hg or 83.8 mm Hg (13.33 kPa or 11.17 kPa) as specified in this section, the tracheal oxygen partial pressures shall be recorded as noted in 4.1.2.2.

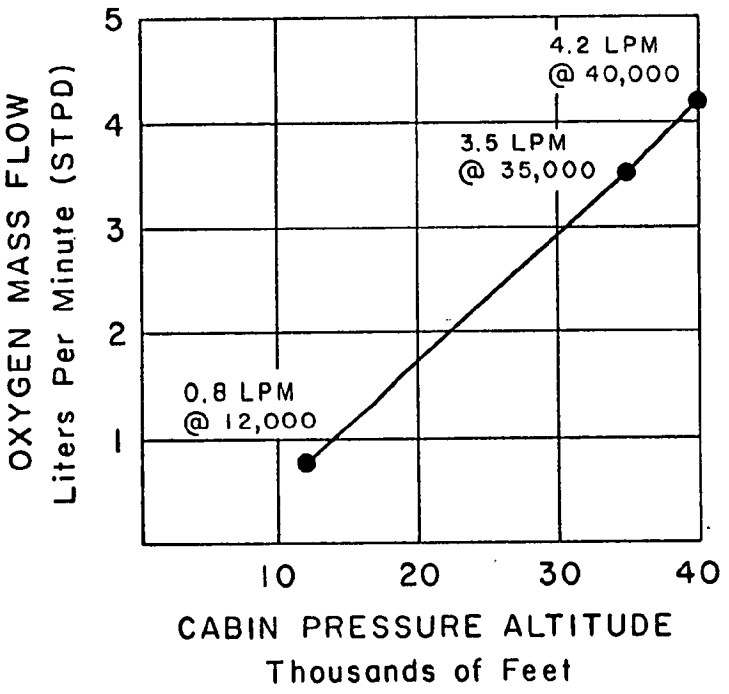
5. QUALITY ASSURANCE PROVISIONS

5.1 The manufacturer shall perform, or cause to be performed, the tests covered in this standard for initial qualification of the mask. Tests called for in paragraphs 3.3, 3.3.1, 4.1.2, 4.1.2.1, 4.1.2.2, and 4.1.3 shall be performed on no less than five representative masks. Tests called for in 3.3.5, 3.4.1.1, 3.4.1.3, and 3.4.1.4 shall be performed on no less than one mask. Each test mask shall be individually identified and representative of production units.

*BTPS - Body temperature (37°C, 98.6°F), Ambient pressure, saturated with water vapor (pH_2O = 47 mm Hg = 6.3 kPa).

PREPARED BY
SAE COMMITTEE A-10, AIRCRAFT OXYGEN EQUIPMENT

APPENDIX 1


OXYGEN MASS FLOW
Liters Per Minute (STPD)
5
4
3
2
1
4.2 LPM
@ 40,000
3.5 LPM
@ 35,000
0.8 LPM
@ 12,000
10
20
30
40
CABIN PRESSURE ALTITUDE
Thousands of Feet