FEDERAL AVIATION AGENCY
FLIGHT STANDARDS SERVICE
Washington 25, D. C.

February 26, 1963

REGULATIONS OF THE ADMINISTRATOR DRAFT RELEASE NO. 63-10

SUBJECT: Technical Standard Order C78 "Oxygen Masks, Demand and Pressure Breathing, Crew (For Air Carrier Aircraft)"

The Flight Standards Service of the Federal Aviation Agency has under consideration an amendment to Part 514 of the Regulations of the Administrator to add a new Technical Standard Order TSO-C78 "Oxygen Masks, Demand and Pressure Breathing, Crew". The reasons therefor are set forth in the explanatory statement of the attached proposal which is being published in the Federal Register as a notice of proposed rule making.

The Flight Standards Service desires that all persons who will be affected by the requirements of this proposal be fully informed as to its effect upon them and is therefore circulating copies in order to afford interested persons ample opportunity to submit comments as they may desire.

Because of the large number of comments which we anticipate receiving in response to this draft release, we will be unable to acknowledge receipt of each reply. However, you may be assured that all comment will be given careful consideration.

It should be noted that comments should be submitted, preferably in duplicate, to the Docket Section of the Federal Aviation Agency, and in order to insure consideration must be received on or before May 6, 1963.

George C. Prill

Director
Flight Standards Service

FEDERAL AVIATION AGENCY

FLIGHT STANDARDS SERVICE

(14 CFR 514)

[Regulatory Docket No. 1622; Draft Release No. 63-10]

Technical Standard Orders for Aircraft Materials, Parts and Appliances

NOTICE OF PROPOSED RULE MAKING

Pursuant to the authority delegated to me by the Administrator (§ 11.45, 27 F.R. 9585), notice is hereby given that the Federal Aviation Agency has under consideration a proposal to amend Part 514 of the Regulations of the Administrator by adopting a new Technical Standard Order. This Technical Standard Order establishes minimum performance standards for aircraft crew demand and pressure breathing oxygen masks for use on civil aircraft of the United States engaged in air carrier operations. The design and testing requirements of the FAA Standard will provide an adequate and uniform basis for the approval of crew oxygen masks as an important component of an oxygen system. In order to provide for the use of such TSO approved crew oxygen masks by the air carrier, specific amendments to Parts 40, 41, and 42 will be necessary. It is anticipated that such amendments will be made concurrently with or prior to the adoption of the final TSO.

Interested persons may participate in the making of the proposed rule by submitting such written data, views or arguments as they may desire. Communications should be submitted in duplicate to the Docket Section of the Federal Aviation Agency, Room A-103, 1711 New York Avenue, N.W., Washington 25, D.C. All communications received on or before May 6, 1963, will be considered by the Administrator before taking action on the proposed rule. The proposals contained in this notice may be changed in light of comments received. All comments submitted will be available in the Docket Section for examination by interested persons at any time.

This amendment is proposed under the authority of Sections 313(a) and 601 of the Federal Aviation Act of 1958 (72 Stat. 752, 775; 49 U.S.C. 1354(a), 1421).

In consideration of the foregoing it is proposed to amend Part 514 as follows:

By adding the following Section 514.84:

§ 514.84 *Oxygen masks, demand and pressure breathing, crew (for air carrier aircraft)—TSO-C78.*

(a) *Applicability.* Minimum performance standards are hereby established for crew demand and pressure breathing oxygen masks which are required to be approved for use on civil aircraft of the United States engaged in air carrier operations. New models of such crew oxygen masks manufactured on or after the effective date of this section shall meet the standards set forth in Federal Aviation Agency Standard, "Oxygen Masks, Demand and Pressure Breathing, Crew",[1] dated October 1, 1962.

(b) *Marking.* The mask shall be permanently marked in accordance with the marking provisions of § 514.3(d) except for the following:

(1) The serial number and the weight of the mask need not be included;

(2) The class and type of the mask shall be included; and

(3) The approved maximum altitude of the mask shall be included.

(c) *Data requirements.* Seven copies each, except where noted, of the following, shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Agency, in the region in which the manufacturer is located.

(1) Manufacturer's operating instructions and equipment limitations;

(2) Installation procedures with applicable drawings and specifications, limitations, restrictions, and other conditions pertinent to installation. Limitations shall specify the regulators which are capable of providing an oxygen partial pressure or percentage of oxygen required by the applicable Civil Air Regulations and shall include the oxygen system gas flow rate and pressure to the regulator(s) which were used in establishing the mask performance;

(3) One copy of the manufacturer's test report; and

(4) Manufacturer's cleaning and sterilizing procedures and maintenance instructions.

[1] Copies may be obtained upon request addressed to Publishing and Graphics Branch, Inquiry Section, MS-158, Federal Aviation Agency, Washington 25, D.C.

George C. Pratt
Director,
Flight Standards Service.

Issued in Washington, D.C., on February 26, 1963.

FEDERAL AVIATION AGENCY STANDARD
OXYGEN MASKS, DEMAND AND PRESSURE BREATHING, CREW

1.0 PURPOSE

The purpose of this standard is to establish minimum performance standards for Crew Demand and Pressure Breathing Oxygen Mask Assemblies which are to be approved for use by crewmembers in civil aircraft of the United States engaged in air carrier operations.

1.1 Scope

This standard provides performance criteria for crew demand and pressure breathing oxygen mask assemblies when connected to appropriate automatic diluter-demand or pressure-breathing regulators.

The mask assemblies shall be capable of providing to the user the oxygen flow rates prescribed in this standard and conform with the requirements and capabilities as defined herein.

1.2 Test

Inasmuch as measured value of the equipment performance characteristics may be a function of the method of measurement, standard test conditions and methods of test are also included in this standard.

2.0 DESCRIPTION OF EQUIPMENT

2.1 General

The oxygen oronasal and fullface mask assemblies described herein are for dispensing gaseous oxygen from demand, diluter-demand, or pressure-demand breathing-type oxygen regulators. Each mask assembly shall include a facepiece, an appropriate suspension device, a valve or valves, an oxygen supply tube assembly and any other components required to complete the assembly. If a microphone is furnished with the mask, the microphone shall comply with TSO–C58, Aircraft Microphones.

2.2 Class

This standard covers the following classes of mask assemblies:

(a) Class "A", Oronasal, Demand
(b) Class "B", Oronasal, Pressure-Demand
(c) Class "C", Fullface, Demand
(d) Class "D", Fullface, Pressure-Demand

2.2.1 *Oronasal*

The oronasal mask shall be designed to cover at least the nostrils and mouth without interferring significantly with eyeglasses, goggles, or communication means. The mask shall be capable of being used as a protective breathing mask when used in conjunction with protective goggles.

2.2.2 *Fullface*

The fullface mask shall be designed to cover at least the mouth, nose and eyes, and to protect the user from the harmful effects of gases or vapor.

2.3 Type

2.3.1 *Ready Type*

Each ready type mask assembly shall be capable of:

(a) being kept in a condition for ready use;
(b) being located to be within the immediate reach of the flight crewmember while at his duty station; and
(c) being rapidly placed on the face from its ready position, properly secured, sealed and supplying oxygen upon demand.

In addition, each ready type mask for flight crewmembers shall be so designed that upon completion of the donning action, the assembly does not prevent the crewmember from being able immediately to communicate with other crewmembers over the airplane intercommunication system. Ready masks shall be of the ready wear type or the ready reach type. The ready wear type shall be designed to be worn on the person. The ready reach type shall be designed to be installed in the airplane in a ready position. Each ready mask shall be identified as follows:

(1) Ready wear type (RW Type)
(2) Ready reach type (RR Type)

2.3.2 *Quick-Donning Type*

Each quick-donning type mask assembly shall be capable of meeting the criteria specified for ready type mask assemblies. In addition, the quick-donning type mask assemblies shall be capable of being donned, within five seconds, with either hand, without disturbing eyeglasses, or preventing the crewmember when using the mask from executing his assigned normal or emergency duties. Quick-donning masks shall be of the quick-donning wear type or the quick-donning ready type. The quick-donning wear type shall be designed to be worn on the person. The quick-donning ready type shall be designed to be installed in the airplane in a condition for ready use. Each quick-donning mask shall be identified as follows:

(a) Quick-donning wear type (QDW Type)
(b) Quick-donning ready type (QDR Type)

2.4 Material

Materials used in the manufacture of crew oxygen mask assemblies shall not:

(a) contaminate oxygen;
(b) be adversely affected by continuous contact with oxygen;
(c) contain or cause objectionable odors;
(d) be allergenic or irritating when in contact with the skin;
(e) be affected by ozone to a harmful extent;
(f) be less than flame resistant, by treatment or by selection.

2.5 Finish

The finish of the facepiece and other mask components within the field of vision of the user during normal usage shall be nonreflective.

3.0 PERFORMANCE

The test procedures and equipment applicable to a determination of the performance of crew demand and pressure breathing oxygen masks operating under test conditions are set forth in Appendix A of this standard.

3.1 Performance of the Mask

The performance of the mask assembly shall be satisfactory when worn on the face, connected to a regulator of the type used in the mask manufacturer's testing or with any other regulator which is capable of supplying equal or greater oxygen partial pressures or percentages of oxygen and flows within the limits of the negative and exhaust pressures specified in this standard.

3.1.1 *Facepiece Chamber*

The design of the facepiece chamber shall be such that the carbon dioxide level during use shall not exceed two percent at any time during the entire inspiratory cycle and one percent maximum average during the entire inspiratory cycle.

3.1.2 *Vibration and Noise*

The mask, while in use, shall not exhibit excessive vibration, flutter, or chatter characteristics sufficient to be distracting to the wearer, while performing his duties.

3.1.3 *Cleaning*

It shall be possible to clean and sterilize the mask.

3.1.4 *Defogging*

Means shall be provided in the fullface mask which will preclude fogging of lenses and permit the mask to be used under conditions of extreme temperature and pressure changes. Gas circulation within the mask shall preclude a direct flow of gas into the eyes of the user.

3.1.5 *Antifreeze*

Means shall be provided for the simple removal of frost, manually or otherwise, to prevent the formation of frost at the exhalation valve or any other location which could interfere with the operation of the mask.

3.1.6 *Condensation*

Operation of the mask shall not be adversely affected by moisture condensation which could accumulate during use.

3.1.7 *Attachment Provisions*

The suspension device attachments on the facepiece shall be capable of withstanding a static load in all directions of at least 35 pounds for a period of three seconds.

3.1.8 *Vision*

3.1.8.1 *Oronasal*

The oronasal mask assembly shall not interfere significantly with the field of vision of the wearer.

3.1.8.2 *Fullface*

The fullface mask assembly shall be of such size and contour that the user shall have a visual field of at least 120° horizontally and 130° vertically and binocular visual field of at least 90° horizontally and 70° vertically.

3.1.8.2.1 *Lenses*

The lenses shall be of optical quality safety glass or appropriate clear plastic without optical or other defects.

3.1.9 *Connector Warning Means*

Connector fittings, installed at the free end of the mask supply tube, unless the connector is designed for permanent attachment, such as hose clamps or threaded couplings, shall have means provided to alert the user when his tube has inadvertently become disconnected. The fit of the connector components shall be snug and require a pull of at least 15 pounds to separate.

3.2 Flow

There shall be no damage to any of the components when the mask is delivering flow to the user in excess of 120 LPM (BTPS).

3.3 Mask Leakage

The total leak rate including facepiece peripheral leakage shall not exceed 0.10 LPM (BTPS) for any negative pressure from 0.0 to 6.0 inches of water.

3.4 Negative Pressure

The negative pressure within the mask shall not exceed 0.60 inch of water when the inspiratory flow rate is 30 LPM (BTPS) at sea level. At an inspiratory flow rate of 70 LPM (BTPS), the negative pressure within the mask shall not exceed 1.2 inches of water. At an inspiratory flow rate of 120 LPM (BTPS), the negative pressure within the mask shall not exceed 2.5 inches of water.

3.5 Exhaust Pressure

The pressure buildup within the mask without safety pressure shall not exceed 0.80 inch of water, when discharging a flow of 30 LPM (BTPS) at sea level. At a flow of 70 LPM (BTPS), the pressure buildup shall not exceed 2.0 inches of water, and at a flow of 120 LPM (BTPS) shall not exceed 3.0 inches of water. For pressure-demand masks, the pressure buildup within the mask shall be within the limits specified in this standard.

3.6 Vibration

The mask assembly shall function satisfactorily and not be adversely affected when subjected to vibrations of the following characteristics:

Cycles per Second	*Maximum Double Amplitude (Inches)*	*Maximum Acceleration*
5–500	0.036	5g

* The term "double amplitude" indicates total displacement from positive maximum to negative maximum. In addition, valves shall not operate inadvertently under applied loads corresponding to 10g applied in any direction.

3.7 Cycling

The mask shall operate satisfactorily after being subjected to 50,000 simulated breathing cycles following the regime outlined in Appendix A.

3.8 Oxygen Supply Tube Leakage

The oxygen supply tube between the oxygen regulator and the mask shall not leak or show signs of damage when subjected to an internal gas pressure of 1.5 pounds per square inch.

3.9 Extreme Temperatures and Humidity

The mask assembly shall be capable of being stored at a temperature of 160° F. for 12 hours and at −67° F. for 2 hours at relative humidities varying from 5 percent to 95 percent with no adverse effects on the mask performance upon return to room temperature. The mask facepiece shall not be gummy or sticky and shall provide a normal seal on the face after the high temperature storage test.

3.10 Low Temperature Test Delay

(a) The mask assembly when tested at 70° F. shall function properly without appreciable delay, after being stowed for at least 2 hours at −40° F.

(b) The mask assembly shall be capable of immediate and continuous operation in a −40° F. environment for a minimum of 15 minutes after being stowed at 70° F. for 12 hours.

3.11 Sudden Loss of Pressure

The mask assembly, when worn, shall be capable of withstanding without permanent functional impairment a sudden loss of cabin pressure from 12.2 pounds per square inch to the pressure existing at the maximum approved altitude of the mask assembly within 10 seconds. If this is not feasible, compliance with Paragraph 3.11.1 is required.

3.11.1 *Pressure Relief Valve*

A pressure relief valve, when installed, shall be capable of maintaining the pressure buildup in the mask below 16 inches of water pressure

differential when the mask is in use during a rapid decompression.

NOTE: The relief valve should be capable of opening at approximately 12 inches of water pressure differential and allow a maximum pressure buildup of 14 inches of water while relieving the mask assembly gas content to 10 inches of water pressure within a 5-second interval. Ite should close at a pressure differential of approximately 10 inches of water.

3.12 Human Subject

The validity of the breathing machine performance shall be demonstrated on human subjects. Subjects may be familiar with oxygen equipment to the extent expected of flight crewmembers and may be instructed to adjust the mask assembly for comfort as would be done in actual flight conditions. During all tests, the mask shall be held in place on the face by the suspension device only. In all tests, all subjects shall reach a rate of approximately 30 LPM (BTPS), both at ground level and at an altitude within 5,000 feet of the maximum altitude for which approval is desired.

APPENDIX A

TEST EQUIPMENT AND PROCEDURES

Tests shall be conducted at laboratory ambient conditions with test apparatus capable of applying suction to the mask and indicating pressure. The apparatus shall, also, be capable of supplying leakage data arising from the fit of the mask to the face. This apparatus should not significantly affect mask fit or performance. It is the responsibility of the manufacturer to work out his own arrangements for carrying out the required tests, performing the amount of required data reduction and preparing the required test report. Test procedures and equipment which provide equivalent information may be used.

1.0 TEST CONDITIONS

1.1 Atmospheric Conditions

When the pressure and temperature are not specified, tests will be made at approximately 29.92 inches of mercury and at room temperature. When pressures and temperatures are other than 29.92 inches of mercury and 70° F. respectively, all flow measurements shall be corrected to these values.

1.2 Gas

The oxygen used to test the mask on human subjects shall be aviation breathing oxygen containing not less than 99.5 percent by volume oxygen and not more than 0.02 milligrams of water vapor per liter of gas at 70° F. and 760 millimeters of mercury. Water pumped air or nitrogen having an equivalent dryness of oxygen may be substituted for aviation oxygen in tests where human subjects are not used. If nitrogen or any other gas is used, density correction factors shall be applied.

1.2.1 *Gas Sampling*

The end expiratory gas sampling method shall be used to obtain gas samples when a breathing machine is used. All gas samples shall be taken during stabilized conditions. Sampling and analytical techniques shall be in accordance with commonly accepted procedures.

1.2.1.1 *Oxygen Partial Pressure Determination*

These methods shall be used to reaffirm that the mask will deliver to the human the same percentage of oxygen as determined on a breathing machine. Oxygen partial pressure shall be measured by one of the following methods.

1.2.1.2 *Direct Measurement*

The total percentage of oxygen in the inspired gas shall be measured directly. In direct measurement, care must be taken to measure a thoroughly mixed gas rather than a stratified layer.

1.2.1.3 *Gas Analysis Method*

The total percentage of oxygen in the inspired gases reaching the lungs shall be estimated by adding the percentage of oxygen and the percentage of carbon dioxide in the expired end tidal gases, or alternatively by subtracting the percentage of nitrogen in the expired end tidal gases from unity. All samples shall be taken during stabilized conditions.

1.2.1.4 *Arterial Blood Oxygen Saturation (Oximeter) Method*

The subject's arterial blood oxygen saturation shall be determined by use of a continuous recording oximeter. A "base line" of blood oxygen saturation shall be established for each subject. Throughout the test, a dip below this "base line" shall not be allowed. Insofar as possible, the test subject shall be exposed to the same conditions when the "base line" is being established as those to which he will be exposed during the altitude mask testing. This shall include such things as his sitting posture, degree of activity, instrumentation and other devices which might affect his blood oxygen saturation.

1.2.2 *Minute and Tidal Volume Determination*

To obtain minute and tidal volumes of the magnitude specified in the Civil Air Regulations, induced hyper-ventilation or a standard exercise

shall be performed under close medical supervision.

NOTE: To simulate a representative degree of expected passenger excitement, etc., exercise corresponding to walking at 2 and 4 miles per hour should result in minute volumes of the order of 15 and 30 LPM (BTPS), respectively.

Exercise seems to be the most critical procedure for obtaining the minute volumes specified in the regulations. It is possible that the higher level of exercise does raise the metabolic rate (oxygen consumption) somewhat more than do other measures for obtaining the required minute volumes. However, exercise should have no effect on the oxygen partial pressure of the inspired air and should have only slight effects on the partial pressure of oxygen of the alveolar air and on oximeter readings. The minute and tidal volumes so obtained should permit performance values to be extrapolated graphically or by other suitable means to provide for an estimated 95 percent of the population when breathing in accordance with the minute and tidal volumes specified in the Civil Air Regulations. Minute volumes may also be directly determined on the subject by collecting the expired gas in equipment suitable for the purpose. The tidal volume may be taken as the minute volume divided by the number of respirations per minute.

2.0 TEST EQUIPMENT

Test equipment prescribed herein has been found to be acceptable in demonstrating compliance with the provisions of the standard contained herein.

2.1 Breathing Machine

The breathing machine shall be designed to simulate closely the human breathing system and have dynamic pressure characteristics similar to those present in human respirations. The machine shall simulate the breathing pattern of inhalation and exhalation and the mixing action in the human lungs, provide a tight gas seal, and afford good mixing of the gas. Provisions shall be incorporated for varying the number of breaths per minute from zero to approximately 80 and the total volume (the amount of gas exhaled per breath) from zero to 2,000 cubic centimeters. The simulated tracheal tube shall approximate the human trachea in its volume and diameter, approximately 100 cubic centimeters and ¾ inch, respectively. The simulated mouth shall be cylindrical or approximate a cylinder with 50 cubic centimeters volume when the mouth diameter is approximately 1 inch. The facepiece design shall simulate a replica of a human face or equivalent, and shall permit sealing the test mask against the replica. Means shall be provided adjacent to the mouth cylinder to permit the application of calibrated peripheral leakage into the mask. In addition, means shall also be provided to permit gas samples to be taken. The sampling means in the mouth shall be directed downward in the trachea to avoid any possibility of enriched readings caused by oxygen impingement. The sample gas shall be continuously circulated at a low flow rate through the mouth to avoid affecting the composition of the mouth gases.

2.2 Oximeter

An oximeter shall be used to estimate the arterial oxygen saturation of each test subject at altitude. Care shall be taken to properly use this type of instrument so that the results obtained will be reliable within the reliability of the instrument.

3.0 TEST PROCEDURES

Test procedures prescribed herein have been found to be acceptable in demonstrating compliance with the provisions of the standard contained hereinbefore.

3.1 Breathing Machine

The mask shall be functionally tested on a breathing machine to test the operation of the inhalation and exhalation valves and to determine mask leakage to assure that the mask is capable of delivering to the user the oxygen supplied by the regulator less the amount lost by leakage.

3.2 Leakage Test

3.2.1 *Mask Leakage*

(a) The facepiece periphery of the mask shall be sealed against a replica of a human face or some equivalent test fixture. The mask inlet valve shall be held open and the loose end of the oxygen supply tube sealed. The inward leakage under 0.0 to 6.0 inches of negative water pressure at sea level shall not exceed 0.10 LPM (BTPS).

(b) After the above tests have been completed, the facepiece periphery of the mask shall be sealed against the faces of humans and the in-

ward leakage under 0.0 to 6.0 inches of negative water pressure at sea level shall not exceed 0.10 LPM (BTPS).

3.2.2 *Inward Flow Resistance*

The facepiece periphery of the mask shall be sealed against a replica of a human face or some equivalent test fixture with the loose end of the oxygen supply tube open. The negative pressure within the mask shall not exceed 0.60 inch of water when the flow is 30 LPM (BTPS). When the flow is 70 LPM (BTPS), the negative pressure shall not exceed 1.2 inches of water. Where the flow is 120 LPM (BTPS), the negative pressure shall not exceed 2.5 inches of water.

3.2.3 *Outward Flow Resistance*

The periphery of the mask facepiece shall be sealed and the free end of the oxygen supply tube connected to the test gas source through an appropriate measuring device. The differential pressure between the interior of the facepiece and ambient shall not exceed 0.80 inch of water pressure at a steady gas flow of 30 LPM (BTPS). At a steady flow of 70 LPM (BTPS), the differential pressure shall not exceed 2.0 inches of water pressure. At a steady flow of 120 LPM (BTPS), differential pressure shall not exceed 3.0 inches of water pressure. For pressure-demand masks, the differential pressure shall be within the exhaust pressure limits specified in Paragraph 3.2.4 of this appendix.

3.2.4 *Exhalation Valve Test* (for masks with pressure compensated exhalation valves)

The mask assembly shall be placed in a suitable test stand and a pressure of 20 mm of Hg. applied to the mask tubing. The pressure at the mask tubing shall then be gradually reduced, causing the inlet valves to close and causing a pressure differential to be applied across the exhalation valve. The mask exhalation valve shall open with a pressure in the tubing between 15 and 19.9 mm of Hg.

3.3 Strength Test

The mask shall be supported by the inlet end of the oxygen supply tube and a static force of 30 pounds shall be applied to the facepiece for a period of at least 3 seconds. The assembly shall suffer no damage which could adversely affect subsequent operation.

3.4 *Oxygen Supply Tube*

One end of the supply tube shall be supported by a fitting which simulates the mask connection. The other end shall be connected to a fitting which simulates the regulator connection. A weight of 30 pounds shall be attached to the hose, so as to exert a straight pull on the tubing, for a period of at least 3 seconds. The tube shall not tear, suffer any damage or be adversely affected in such a way as to impair the safety or performance of the equipment. After the static weight test, the supply tube shall be subjected to an internal air pressure of 1.5 p.s.i. There shall be no leakage or visible damage to the tube assembly after being subjected to the tests.

3.5 High Temperature Exposure Test

The mask shall be placed in an atmosphere of 160° F. for a period of 12 hours. The mask shall then be placed on a breathing machine and the tests specified in Paragraph 3.2 shall be performed. The breathing machine tests shall begin within 15 minutes from the time the mask is removed from the hot atmosphere. The mask shall function satisfactorily and shall not be gummy or tacky when returned to room temperature. Repetition of the breathing machine test should produce corresponding results as originally obtained.

3.6 Low Temperature Exposure Test

The mask shall be stowed in an atmosphere maintained at −67° F. for a period of 2 hours. The mask shall then be tested within 15 minutes at room temperature for pliability of the flexible components and per Paragraph 3.2. There shall be no visible damage to any portion of the mask and repetition of breathing machine tests shall produce corresponding results as originally obtained.

3.7 Low Temperature Shock Operation—Human Subject

While wearing and using a mask at room temperature, connected to an oxygen walk-around bottle and regulator, a subject shall step into an atmosphere maintained at −40° F. The subject wearing and using the oxygen mask, shall remain in the low temperature environment for a period of at least 15 minutes. There shall be no adverse effect on the operation of the mask during or after this period. The oxygen supply tube and

facepiece shall remain pliable during the test. The mask shall operate satisfactorily during its exposure to the low temperature.

NOTE: Use of undiluted (100 percent) oxygen by the subject to avoid dilution with air −40° F. is acceptable.

3.8 Human Subjects

Tests on human subjects shall be performed under close medical supervision and the usual precautions in this type of test shall be observed. Individuals being subjected to altitude tests shall be medically screened before being placed in an altitude chamber. In such tests, the following are considered to be normal precautionary measures and shall be observed.

(a) The mask shall be put on before a dangerously high altitude is reached.

(b) If the subject is not getting sufficient oxygen to maintain himself during the course of the experiment, or for any other reason that might make continuance of the test dangerous, descent shall be made immediately.

NOTES:

1. If any of the early symptoms of an evolved gas dysbarisms develop, such as bends, paresthesias, etc., the chamber should be immediately lowered. This is in addition to hypoxia symptoms.

2. Preoxygenation of the subject prior to ascending to altitudes above 25,000 feet is considered desirable as a safety precaution. The subject should prebreathe 100 percent oxygen for at least 30 minutes if it is anticipated that he will remain above 25,000 feet in excess of 5 minutes.

3. On the test subjects, the percentage or partial pressure of oxygen reaching the lungs should be determined as specified herein.

3.8.1 Sea Level

The subject shall don the mask and adjust it for comfort. With the oxygen regulator in the "100%" oxygen position, the subject shall breathe oxygen through the mask for a period of at least 10 minutes. Safety pressure shall not be used through the mask, a ventilation rate of approximately 30 LPM (BTPS) shall then be induced for a period of 3 minutes. At the end of each period the measured percentage of oxygen in the inspired gas mixture shall be 95 percent or greater as measured by any of the generally acceptable standard methods.

3.8.2 *Altitude*

When the method of Appendix A, Paragraph 1.2.1.2, is used, the procedures shall be as follows: Ascend to 5,000 feet without oxygen and take expired gas samples which shall be used to validate the sampling analysis techniques. With either procedure, after the measurements at 5,000 feet and preoxygenation have been completed, the subject shall put on the test mask assembly and ascend to the maximum altitude for which approval is desired, level off, and remain at that altitude until oxygen saturation stabilizes for at least 1 minute. The lowest reading for blood oxygen saturation or oxygen partial pressure obtained shall be recorded. The reading shall not fall below the "base line" values established in Appendix A, Paragraph 1.2.1.3. The subject shall then descend at steps which are not greater than 7,500 feet. The blood oxygen saturation or oxygen partial pressure shall be taken at each of these intervals.

When the procedures of Appendix A, Paragraph 1.2.1.3, are used, the procedure shall be as follows: Affix an oximeter to a seated subject breathing ambient air in an altitude chamber and ascend to 5,000 feet. Level off and for a period of 3 minutes establish his blood saturation. The resulting recorded percent saturation shall be the subject's "base line" for altitude up through 35,000 feet. Descend to ground level for a period of preoxygenation.

3.9 Vibration

The mask shall be dynamically vibrated similarly to the most severe conditions likely to be encountered in service. The vibration equipment shall vibrate along each of the three mutually perpendicular axes of the mask. The vibration frequencies and amplitude shall be as specified in the standard.

3.10 Resonance

A frequency survey shall be made along each of the three perpendicular axes of the mask over the frequency range specified in the standard. The maximum double amplitude and the maximum acceleration shall not exceed the values specified in the standard. If resonance is observed, the mask shall be vibrated for one million cycles or 8 hours, whichever occurs first at the same amplitude and direction the resonance was observed.

NOTE: When resonant frequencies are not apparent, within the specified frequency range, the mask should be vibrated at the maximum double amplitude specified and at a frequency which will provide maximum accelerations of 5g.

3.11 Cycle Test

The mask shall be subjected to 50,000 total simulated breathing cycles. Forty percent of the cycles shall be at the rate of 20 cycles per minute with a minute volume of 20 LPM (BTPS) with 1 liter exchange per cycle. Fifty percent of the cycles shall be at 30 LPM (BTPS), minute volume at 20 cycles per minute with 1.5 liters exchange per cycle and at least 10 percent of the total cycles at 70 LPM (BTPS) minute volume rate at approximately 35 cycles per minute and approximately 2 liters per cycle volume exchange. A constant time interval between respirations shall be maintained in each case.

3.12 Microphone Functional Test

The operation of the microphone shall not be adversely affected by the tests.

3.13 Carbon Dioxide Determination

When the mask is worn by a human subject, the carbon dioxide level in the facepiece chamber shall not exceed 2 percent of the total volume at any time during the entire inspiratory cycle and 1 percent average during the entire respiratory cycle.

3.14 Vision

The fullface mask shall be tested to any of the recognized methods for testing binocular vision for compliance with the provisions of the standard.

4.0 REQUIRED TESTS

4.1 Design Qualification

The manufacturer shall perform the tests covered by this standard for initial qualification of the mask. These tests shall be conducted on a minimum of five masks except that the vibration, cycling and temperature tests may be conducted on only one mask. The mask performance tests on human subjects shall be conducted on at least 10 subjects. At least five of these subjects shall be subjected to the required low temperature shock operation and attitude tests. Each test mask shall be representative of production units and shall be individually identified.

4.2 Individual Performance

Each mask assembly bearing the TSO label of this standard shall be subjected to the following tests:

(a) Leakage Test, Appendix A, Paragraph 3.2.

(b) Strength Test, Appendix A, Paragraph 3.3.

4.3 Random Sampling

One mask shall be selected at random from each lot of masks and subjected to the design qualification tests. During the random sampling tests, the tests which involve human subjects may be omitted.

5.0 TEST OMISSIONS

Although specific tests are not required to demonstrate compliance with every requirement of this standard, this does not release the manufacturer from the responsibility of furnishing crew demand and pressure breathing oxygen masks which are capable of meeting these requirements.

6.0 ABBREVIATIONS AND DEFINITIONS

Symbol	*Definition*
LPM	Liters per minute.
BTPS	Body temperature, Pressure, Saturated (98.6° F. ambient pressure, saturated with water vapor at 98.6° F.).
° F	Degrees Fahrenheit.
g	Gravity.
Flame resistant	Flame resistant material is material which will not support combustion to the point of propagating, beyond safe limits, a flame after the removal of the ignition source.

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