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AEROSPACE STANDARD

SAE AS452

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Oxygen Mask Assembly, Demand and Pressure Breathing, Crew

1. PURPOSE:

The purpose of this standard is to establish optimum standards for crew demand and pressure-breathing oxygen mask assemblies for use by crew members in civil aircraft.

2. SCOPE:

This standard covers both general type and quick-donning type mask assemblies in the following classes:

a. Class A, oronasal, demand
b. Class B, oronasal, pressure-demand
c. Class C, full face, demand
d. Class D, full face, pressure-demand

3. GENERAL REQUIREMENTS:

3.1 Performance:

The performance of the mask assembly shall be satisfactory when worn on the face, connected to a separately mounted or mask-mounted regulator of the appropriate type, demand or pressure demand. Demand masks and regulators are those designed for delivering to the user either pure (100%) oxygen or a mixture of oxygen and air, in any volume or at any rate of flow required by the natural respiration of the user. The demand equipment is suitable for routine use up to 35,000 ft cabin altitude and is intended to be suitable for emergency (few minutes) use up to 40,000 ft cabin altitude.

Pressure-demand masks and regulators function as demand or diluter demand equipment up to approximately 30,000 ft. Above this altitude the regulator delivers to the user oxygen under pressure varying with altitude, and is intended to be suitable for routine use up to 42,000 ft cabin altitude and emergency (few minutes) use up to 45,000 ft.

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3.2 Oxygen Supply System:

The mask assemblies described herein are for dispensing gaseous oxygen from demand or pressure-demand breathing type oxygen regulators, including mask-mounted regulators.

The mask when connected with the appropriate type of regulator (demand or pressure demand) becomes an integral part of the oxygen system. Therefore, certain performance requirements in this standard stem from, or are established to assure compatibility with, the oxygen regulator requirements.

3.3 Components:

Each mask assembly shall consist of the following components where applicable:

a. Facepiece
b. Suspension device
c. Valve or valves
d. Supply tube assembly
e. Microphone
f. Miscellaneous additional accessories as required

3.4 Materials and Workmanship:

3.4.1 Materials: The materials used in the manufacture of 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. A flame resistant material is defined as one which will not support combustion to the point of propagating a flame, beyond safe limits, after the removal of the ignition source, in an atmosphere of air at ground level.

3.4.1.1 Finish: The finish of the facepiece and other components within the field of vision of the user shall be non-reflective.

3.4.2 Workmanship: Shall be consistent with accepted high grade aircraft equipment practice.

3.5 Identification:

The following information should be legibly and permanently marked on the mask assembly:

a. SAE AS 452A
b. Class, per paragraph 2 of this standard
c. Type, as follows:

NQD (Non-Quick Don)
QDW (Quick-Donning Wear)
QDS (Quick-Donning Stow)
QDW/S (Quick-Donning Wear or Stow)

d. Cure date of the oldest natural or synthetic rubber or rubberlike part.
e. Manufacturer's part number.
f. Manufacturer's name or trademark.
g. Size (small, medium, large, regular normal, regular wide, etc. or universal fit). Abbreviations S, M, L, RN, Rw or UF may be used.
h. Maximum approved altitude.

3.6 Cleaning:

It shall be possible to clean and sterilize the mask without adverse effects on its operation and performance. The manufacturer shall provide adequate cleaning instructions with each unit.

4. DETAIL REQUIREMENTS:

4.1 Designation:

The following type designations shall be used as applicable:

4.1.1 Type NQD (Non-Quick Don): This mask shall be designed to be worn on the person only when in use. When not in use this mask may be stowed in the aircraft accessible to the crew members but not necessarily connected to an oxygen outlet.

4.1.2 Type QDW (Quick-Donning Wear): This mask shall be designed to be worn on the person, ready for quick donning and immediate use and connected to the oxygen outlet.

4.1.3 Type QDS (Quick-Donning Stowage): This mask shall be designed for stowage in the aircraft, within reach of the crew member, ready for quick donning and immediate use, connected to the oxygen outlet.

4.1.4 Type QDW/S (Quick-Don Wear or Stow): This mask combines the requirements of 4.1.2 and 4.1.3 above.

4.2 General:

Each mask assembly shall be designed so that it shall be capable of being quickly and easily connected to an oxygen outlet and without interferring significantly with eyeglasses capable of being easily placed on the face from its ready, or stowed position, properly secured, sealed, and supplying oxygen.

In addition, upon completion of the donning action, the assembly does not prevent the crew member from being able to communicate immediately over the aircraft communication and intercommunication systems.

4.2.1 Masks for Use with Mask-Mounted Regulators: With the exception of the oxygen supply tube, no specific requirements are indicated as optional or not applicable since, depending on the design, all could be applicable. Where a requirement is also covered in the breathing oxygen regulator standard, the mask standard should apply since the mask is the end result and depends on the performance of the regulator in any event. Therefore, the test report showing compliance with the requirements of this standard may reference and include regulator test data as applicable or, where testing to meet both standards can be accomplished by a single test (or series of tests), such as life cycle endurance testing, this can be appropriately accomplished and documented.

4.3 Quick-Donning Type:

Each quick-donning type mask assembly shall be capable of meeting the criteria specified under general requirements of mask assemblies. In addition, the quick-donning mask assemblies shall be capable of being donned, within 5 sec, with either hand, independently, without preventing the crew member from executing his assigned normal and emergency duties.

4.4 Oronasal:

In addition to complying with the general requirements of 4.2, the oronasal mask shall be designed to cover at least the nostrils and mouth. The mask shall be capable of being used as a protective breathing mask when used in conjunction with protective goggles. The mask assembly shall not interfere significantly with the field of vision of the wearer.

4.5 Full Face:

In addition to complying with the general requirements of 4.2, the full-face 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.

4.5.1 Vision: The full-face mask assembly shall be of such size and contour that the user will have an adequate field of vision. The viewing lens(es) in meeting the following minimum requirements will provide adequate vision.

The minimum visual area provided for each eye, when measured from a point at the center of the eye, shall extend horizontally to 75 deg in a temporal or outward direction, 50 deg in a nasal or inward direction, and vertically to 50 deg upward and 60 deg downward. This minimum visual area shall transition smoothly between these limits and shall contain no fittings or other projections that might restrict visibility, such as the mask structure between the eye-pieces of a dual-lens-type face mask.

4.5.2 Lenses: The lenses shall be of optical quality safety glass or appropriate clear plastic without optical or other defects. Provisions should be made for replacement of the lens when required or desired.

4.5.3 De-Fogging: Means shall be provided in the full face mask which will preclude any unsatisfactory fogging of lenses and permit the mask to be used under conditions of expected temperature and pressure changes. Gas circulation within the mask shall be directed to preclude a direct flow of gas into the eyes which would interfere with vision of the wearer.

4.6 Size and Fit:

The mask shall be designed to fit at least the 5 through 95 percentile flight crew population. Reference may be made to USAF WADC TR 52-321 “Anthropometry of Flying Personnel” for basic facial measurements. A sizing and/or fit program shall be established to assure compliance. An example of a satisfactory sizing program is described in USAF WADC TR 58-505 “Anthropometric Sizing and Fit-Test of the MC-1 Oral-Nasal Oxygen Mask.” The use of facial forms as described in this report is recommended particularly if the forms can also simulate the relative resiliency of the human face. Tests on representative human subjects shall also be made.

4.7 Connector Warning Means:

If quick disconnect fittings are installed at the free (or regulator hose) end of the mask supply tube, means shall be provided to alert the user when his tube has inadvertently become disconnected. If valving is used to increase the inhalation resistance with the tubing disconnected, the negative pressure should be within the range of 7 to 9 in. of water. For universal use and interchangeability the connector should mate with the MS 24552 (or equivalent) connector. The fit of the connector components shall be positive and require a pull applied parallel with the longitudinal axis of the tube of at least 15 lb to separate.

4.8 Defrost:

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

4.9 Communication:

Microphones shall be in accordance with FAA TSO-C58. Communication shall not be adversely affected by operation of the inhalation exhalation valve(s).

4.10 Suspension Device:

The mask harness or suspension device shall be adjustable to permit fitting as well as snugness of fit when required. The suspension device design shall prevent relative movement (upward, downward, sideward) of the mask with respect to the face under acceleration up to three times the force of gravity. Primary design consideration shall be to provide a means to couple the mask to the face securely in the proper position. It shall not be possible for the suspension device to tangle, twist, or hang up on personal or cockpit equipment. Only minor post donning adjustment shall be necessary for individual fit and comfort. The mask design should provide comfort essential to permit wearing and using the mask for a period of several hours.

4.11 Attachment Provisions:

The suspension device attachments on the facepiece shall be capable of withstanding a static load in all directions of at least 25 lb for a period of 3 sec.

4.12 Orientation:

The mask valves shall operate with the mask in any position.

4.13 Pressure Demand Operation:

The exhalation valve shall be pressure compensated to prevent overboard dumping of oxygen supply during inhalation under regulator pressures of 0.5 to 14.0 in. of water and flows of 1.0 to 135 LPM (liters per minute flow).

4.14 Handling Resistance:

The mask shall be capable of withstanding any normal handling incidental to inspection, testing, storage, shipping, and use without damage, failure, or permanent deformation.

5. PERFORMANCE REQUIREMENTS:

5.1 Vibration:

In its stowed configuration the equipment shall be capable of withstanding vibration, as follows:

5.1.1 Resonance: One million cycles or 8 hr, whichever occurs first, at each resonance occurring within the frequency range of Figure 1. (Where several resonances are encountered the vibration periods may then be limited to those resonances considered most likely to produce failure.)

5.1.2 No Resonance: One million cycles in each of three mutually perpendicular directions, at 100 cps and the corresponding amplitude of Figure 1.

5.2 Extreme Temperatures and Humidity:

The mask assembly shall be capable of being stowed at a temperature of 160 F for 12 hr and at -67 F for 12 hr with no adverse effects on the mask performance upon return to room temperature. The mask facepiece shall not be gummy or sticky after the high temperature stowage test and shall provide a normal seal on the face after high and low temperature tests.

5.3 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 hr at -40 F.

b. The mask assembly shall be capable of immediate and continuous operation in a -40 F environment after being stowed at 70 F for 2 hr.

5.4 Altitude:

Mask assemblies shall function at all altitudes between sea level and the maximum permitted by the regulator (demand or pressure demand), or the maximum approved altitude, whichever is lower.

5.5 Condensation:

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

5.6 Vibration and Noise:

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

5.7 Mask Leakage:

With the mask properly secured to the face, the total inward leak rate, including facepiece peripheral leakage, shall not exceed 0.10 LPM for any negative pressure from 0 to 6.0 in. of water. Pressure-demand masks shall also be tested for any positive pressure from 0 to 14 in. of water for outward leakage by means of qualitative testing of paragraph 6.5.3.

5.8 Cycling:

The mask assembly shall operate satisfactorily after being subjected to 250,000 simulated breathing cycles in accordance with paragraph 6.4.12.

5.9 Oxygen Supply Tube Leakage:

The oxygen supply tube between the regulator or open end and the mask shall not leak or show signs of damage when subjected to an internal gas pressure of 1.5 psi. The mask-mounted regulator supply hose shall be tested at a pressure equal to 1.5 times the normal maximum operating pressure.

5.10 Demand Operation:

5.10.1 Inhalation Resistance: The negative (differential) pressure in the mask below ambient pressure shall not exceed the following:

Flow (LPM)	Differential Pressure (In. H_2O) Max
0.1 - 1.0	0.70
50	1.0
100	2.0

5.10.2 Exhalation Resistance: The positive (differential) pressure in the mask above ambient pressure shall not exceed the following:

Flow (LPM)	Differential Pressure (In. H_2O) Max
0.1 - 1.0	0.70
50	1.5
100	2.5

5.11 Pressure Demand Operation:

5.11.1 Exhalation Resistance: The positive differential pressure (mask over regulator supply pressure) shall be between 0.1 and 1.5 in. of water with an outward flow range of 1.0 to 50 liters per minute and a pressure of 0.5 to 14 in. of water in the mask tubing. At a flow of 100 LPM, the differential pressure shall not exceed 2.5 in. of water.

5.11.2 Exhalation - Valve Opening: The valve shall open at the following pressures: (a) 20 mm Hg in the facepiece with 17 - 19.9 mm Hg in the inlet tubing; and (b) 5 mm Hg in the facepiece with 2 - 4.9 mm Hg in the inlet tubing.

5.12 Sudden Loss of Pressure:

The mask assembly, when worn, shall be capable of withstanding, without permanent functional impairment, a sudden (within 10 sec) loss of cabin pressure from 12.2 psi abs (approximately 5000 ft altitude) to the pressure existing at the maximum approved altitude of the mask assembly.

5.13 Suction-Unseating of Exhalation Valve:

The valve shall not be unseated when subjected to a suction of 20 in. of water inside the facepiece with the supply tube sealed.

5.14 Acceleration-Unseating of Exhalation Valve:

The valve shall not be unseated when subjected to acceleration up to three times the force of gravity.

5.15 Leakage-Inhalation Valve Suction:

The inlet or inhalation valve leakage shall not exceed 0.015 LPM when a suction of 0.1 in. of water is applied to the inlet supply tube, nor 0.15 LPM with a suction of 12 in. of water.

5.16 Leakage-Exhalation Valve-Pressure and Suction:

Leakage shall not exceed 0.1 LPM with balanced inhalation and exhalation suction and pressure of 0.5 to 14 in. of water.

5.17 Ozone Resistance:

The elastomer components shall be composed of an ozone resistant composition, and shall meet the requirements specified in the ozone resistance test.

6. QUALIFICATION TESTS:

Representative samples of each mask size and type shall be subjected to at least the tests listed below. The number of masks tested is the responsibility of the manufacturer to assure himself that the production mask is capable of passing the qualification tests.

6.1 Test Methods and Procedures:

Test methods and procedures shall be prepared in detail for approval of the procuring agency prior to accomplishment of the tests. Test set-up schematic, test equipment, instrumentation, and instrumentation calibration shall be included.

6.2 Test Conditions:

6.2.1 Atmospheric Conditions: When the pressure and temperature are not specified, tests will be made at an atmospheric pressure of 28 to 32 in. Hg, a room temperature of 77 ± 18 F, and a relative humidity of 80% or less. When pressures and temperatures vary substantially from the above values, proper allowance shall be made for the change in instrument reading.

6.2.2 Gas: The oxygen used to test the mask on human subjects shall be aviation breathing oxygen containing not less than 99.5% by volume oxygen, and not more than 0.02 mg of water vapor per liter of gas at 70 F and 760 mm Hg. 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.

6.2.3 Tolerances: The maximum allowable tolerances on test conditions shall be as follows:

a. Temperature: ±2 C (3.6 F). (Exclusive of accuracy of instruments.)
b. Altitude: ±5% (in feet).
c. Relative humidity: +5% - 0% (of R.H. value).
d. Vibration amplitude: ±10%.
e. Vibration frequency: ±2%.

6.3 Test Equipment:

6.3.1 Breathing Machine: Breathing machine designs shall simulate the human breathing system and have dynamic pressure characteristics similar to those present in human respirations. The machine shall simulate the human breathing pattern of inhalation and exhalation and provide a tight gas seal. Provisions shall be incorporated for varying the number of breaths per minute, the tidal volume (the amount of gas exhaled per breath), and for measuring flows and pressures.

6.4 Performance Tests (Mechanical):

6.4.1 Mask Inward Leakage - Valve(s) and Valve Installation(s): The facepiece periphery of the mask shall be mounted on a replica of a human face or a suitable test stand with the loose end of the oxygen supply tube sealed, and inward leakage, under 0 to 6 in. of negative water pressure tested at 1-in. increments, shall not exceed 0.10 LPM.

6.4.2 Flow Resistance-Pressure Demand Operation: The periphery of the mask facepiece shall be sealed against a suitable test fixture and the free end of the oxygen supply tube connected to the test gas source through a manually controllable pressure demand regulator and an appropriate pressure measuring device. For the outward flows specified, the differential pressures during simulated pressure breathing shall be within the limits specified in paragraph 5.11.1. The valve may be tested separately or as installed in the mask.

6.4.3 Pressure Demand Operation - Exhalation Valve Opening: The mask assembly shall be placed on a suitable test fixture with the periphery of the facepiece secured and sealed and pressures as specified in paragraph 5.11.2(a) and (b), applied at 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 as specified in paragraph 5.11.2. The valve may be tested separately or as installed in the mask.

6.4.4 Acceleration Dislodgement Test: The mask shall be mounted on a replica of a human face (head) preferably simulating the relative resiliency of the human with the suspension device properly secured and adjusted for normal use. The assembly shall then be tested for dislodgement by accelerations specified in paragraph 4.10.

6.4.5 Decompression Test: The mask shall be mounted using a mask suspension device on the breathing machine or equivalent test fixture to simulate the human breathing system. Place the breathing machine in an altitude chamber and decompress the chamber from approximately 5000 ft altitude to maximum approval altitude in 10 sec. Observe the functioning of the mask during and after the decompression for compliance with paragraph 5.12.

6.4.6 Suction-Unseating of Exhalation Valve: The valve shall be subjected to a suction of 20 in. of water applied to the mask end of the valve with the inhalation valve or supply tubing sealed. The exhalation valve shall not be unseated. (The valve may be tested separately or as installed in the mask.)

6.4.7 Acceleration-Unseating of Exhalation Valve: The valve shall be tested so that axial acceleration is applied in line with the direction of valve operational movement. The valve shall be subjected to acceleration from 0 to 3 g and shall not be unseated. (The valve may be tested separately or as installed in the mask.)

6.4.8 Demand Operation - Inhalation Resistance: Mount the mask assembly on a suitable test fixture and apply a suction source to the inside of the facepiece. With suction applied, test for conformance to paragraph 5.10.1.

6.4.9 Demand Operation - Exhalation Resistance: With a positive pressure source applied to the inside of the facepiece test for conformance to exhalation flows and differential pressures of paragraph 5.10.2.

6.4.10 Leakage-Inhalation Valve-Suction: Apply a source of suction to the inlet supply hose. The leakage through the valve seat shall not exceed 0.015 LPM for a suction of 0.1 in. of water nor for a suction of 12 in. of water. If necessary, a suitable means may be used to prevent collapse of the hose.

6.4.11 Leakage-Exhalation Valve-Pressure: Regulate exhalation pressure to obtain a positive flow with inlet or inhalation pressure in range of 0.5 to 14 in. of water. Reduce exhalation pressure to obtain a zero differential pressure. Leakage into the mask facepiece shall not exceed 0.1 LPM.

6.4.12 Cycle Test Using the Breathing Machine: The mask shall be subjected to 250,000 total simulated breathing cycles. Ten (10) per cent of the cycles shall be at the rate of 12 cpm with a minute volume of 10 LPM. Forty (40) per cent of the cycles shall be at the rate of 20 cpm with a minute volume of 20 LPM and 1 liter exchange per cycle. Forty (40) per cent of the cycles shall be at the rate of 20 cpm with a minute volume of 30 LPM and 1.5 liters exchange per cycle and 10% of the total cycles shall be at the rate of 35 cpm with a minute volume of 70 LPM and 2 liters per cycle volume exchange. A constant time interval between respirations shall be maintained in each case. After completion of cycling test, the mask shall be tested as specified in paragraphs 6.4.1 through 6.4.4.

6.5 Performance Tests (Human Subjects):

6.5.1 Mask Inward Leakage: This quantitative test may be performed as an alternative to the qualitative test of paragraph 6.5.2(b). Nitrogen washout tests for mask leakage shall be conducted on at least five subjects for each mask size but on no less than 25 subjects having facial features and sizes representative of the sizing and fit program developed per paragraph 4.6. The test consists of fitting each subject with the appropriate mask instrumented to sample the expired gas. Have the subject breathe 100% oxygen until the nitrogen concentration of the expired gas, as indicated by a nitralyzer (or equivalent), reaches a plateau and remains relatively constant. From the recorded nitrogen concentration, determine the nitrogen content of the expired task. The mask leakage shall not exceed 0.10 LPM (BTPS) (body temperature, ambient pressure, saturated).

6.5.2 Mask Inward Leakage: The following test procedures have been adapted from and are essentially the same as those employed by the Bureau of Mines to assure a gas-tight fit for various protective breathing masks. The tests are qualitative in nature and the b. portion of this test may be performed as an alternate or in addition to the quantitative tests of paragraph 6.5.1.

a. The complete mask assembly shall be fitted to the faces of at least five subjects for each mask size but on no less than 25 subjects having facial features and sizes representative of the sizing and fit program developed per paragraph 4.6. To test the suitability of the fit of the mask on these subjects, the exhalation valve shall be held closed, without disturbing the fit of the mask, and each subject shall exhale gently into the facepiece until a slight but definite positive pressure is built up in the facepiece. The absence of outward leakage of air between the facepiece and each wearer's face shall indicate satisfactory fit of the facepiece.

b. The subjects who participated in the test described in paragraph a. of this section, each wearing the complete mask assembly, shall enter an atmosphere containing 0.10% by volume (1000 ppm) of isoamyl acetate vapor. Ten minutes shall be spent in work designed to provide observation on freedom from leaks, freedom of movement, and freedom from discomfort to the wearers. The mask hose should be connected to a regulator hose of sufficient length to permit the necessary movements of the subjects in performing the following tests. The time shall be divided as follows:

Five (5) minutes - Walking, moving head from side to side, nodding, and bending the body at the waist.

Five (5) minutes - Pumping air with a hand-operated tire pump into a 1-cu ft cylinder to a pressure of 25 lb per square inch gage, or equivalent work.

To meet the requirements of this test no isoamyl acetate shall be detected by odor in the air breathed, and undue encumbrance and discomfort shall not be experienced because of the fit or other features of the respirator. A substitute for the isoamyl atmosphere, preferred for full face masks and half masks with goggles is the use of ammonia gas, one percent by volume concentration, in the test chamber.

CAUTION: Since this concentration is potentially hazardous, proper safety precautions must be used. Reference may be made to "Dangerous Properties of Industrial Materials" by N. Irving Sax, 2nd Edition, published by Reinhold.

6.5.3 Mask Outward Leakage - Pressure Demand Only: The masks shall be donned by human subjects and carefully adjusted. The oxygen mask hose shall be attached to a manually controlled pressure demand regulator (such as the USAF Type A-14). The pressure should then be raised by suitable selection of the manual controls to "safety" pressure. (1.5 ± 0.5 in. of water) and the effectiveness of the seal determined while the subject holds his breath. Minor adjustments in positioning the mask and harness adjustment devices to secure a leak-proof fit are permitted as necessary. The pressure shall then be raised to 41,000, 43,000 and 45,000 ft (4.0 ± 0.5, 6.0 ± 0.5, 8.0 ± 0.5 in. of water, respectively) to continue the determination of the effectiveness of the seal. At least five subjects having varying facial characteristics, representative of the facial size and shapes used in paragraph 4.6, shall be subjected to this test for each mask size and style. If the mask has only one size or style, i.e., for universal fit, 25 subjects shall be tested covering the extremes and several intermediate facial sizes and shapes as developed in paragraph 4.6. There shall be no discernable leakage between the face and the mask facepiece.

6.5.4 Operational Use Test - Ground Level: In order to assure adequate comfort, freedom of movement, effect on vision, vibration and noise (flutter, chatter, etc. of valves), adequacy of connector warning means, effect on communication via the microphone, and the quick donning capability, the following tests are required. Unless otherwise noted the tests shall be repeated for at least five subjects.

a. Quick Donning Capability - Simulate a pilot on duty during flight or use actual aircraft and demonstrate compliance with paragraphs 4.1, 4.2 and 4.3 quick donning capability.

b. Effects on Communication - The effects on communication shall be determined by listening to subjects talking over an intercom system suitable for the microphone installed. Use a manually controlled pressure breathing oxygen regulator to simulate demand and pressure-demand breathing pressures at altitudes up to applicable maximum altitude. The mask valve(s) shall not interfere with communication by creation of any type of noise.

c. Warning Means - While the subject is wearing and using the mask with a quick disconnect, the hose connector shall be disconnected, without the knowledge of the subject. The subject should be purposely distracted from the test objective and engaged in some activity such as a simulated flight problem. The warning means, such as increased resistance to inhalation, shall immediately alert the subject.

d. Comfort - To assure adequate comfort the mask shall be worn by 25 subjects for a minimum of 60 minutes with the mask and suspension device adjusted to prevent leakage. During this time, flight crew members' duties should be simulated at least to include periodic necessary movements of head, arms, body and rising from seated position to lean or move a distance normally permitted (as controlled by length of regulator and mask hose assemblies). For approximately ten minutes the regulator shall be set for pressure breathing (pressure demand masks only).

6.5.4 (Continued):

e. Vision - The full face mask shall be tested to any of the recognized methods for testing binocular vision for compliance with the provisions of paragraph 4.5.1. Oronasal masks shall be subjectively evaluated during the tests of a. thru d.

f. Odor and Allergenic Effect - Odor and effect on skin shall be qualitatively observed during these tests.

6.5.5 Operational Use Tests - Altitude: A minimum of five subjects will be tested at altitude under controlled conditions using an altitude chamber to determine the masks use under the more realistic conditions of reduced barometric pressure. One subject and/or mask will be instrumented to determine mask inboard leakage by any of the generally accepted methods. Since crew masks are normally personally fitted equipment, each subject shall be properly fitted and the mask adjusted as appropriate prior to these tests.

At the beginning of the test the mask shall be donned and adjusted by each subject without assistance. The subjects will be taken to the maximum altitude for which approval is desired and maintained at this altitude from 1 to 3 minutes. Descent should be in steps of 5000 to 7500 ft.

At each check altitude the mask shall be evaluated for:

a. Effects on communication by engaging the subject in conversation over the intercom system.

b. Comfort as observed and commented on by the subject and chamber observers.

c. Mask leakage, quantitatively on the instrumented subject and qualitatively by the other subjects.

d. The necessity for and extent of adjustments of mask to face after donning. (Any adjustments to be accomplished by use of only one hand.)

In addition to the above, quick-don masks shall be tested as follows:

e. At least three subjects shall be subjected to a “slow” decompression from 8000 ft to maximum approval altitude in approximately 30 sec. The subjects will don the masks after start of decompression and perform simulated aircraft emergency descent duties including communication using the chamber intercom system. The mask shall be donned from its intended ready position in no more than 5 sec with one hand, and with no significant interruption of communication over the intercom system without disturbing eyeglasses and without delaying the subject from proceding with simulated emergency descent duties.