ETSO-C89
Date : 24.10.03

European Aviation Safety Agency

European Technical Standard Order

Subject: OXYGEN REGULATORS, DEMAND

1 - Applicability

This ETSO gives the requirements which oxygen regulators, demand type that are manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO Subpart A.

2.2 - Specific

None.

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in the attached Federal Aviation Administration Standard „Oxygen Regulators, Demand".

3.1.2 - Environmental Standard

As specified in Federal Aviation Administration Standard „Oxygen Regulators, Demand".

3.1.3 – Computer Software

None

3.2 - Specific

None.

4 - Marking

4.1 - General

Marking is detailed in CS-ETSO Subpart A paragraph 1.2.

4.2 - Specific

None.

5 - Availability of Referenced Document

See CS-ETSO Subpart A paragraph 3.

FEDERAL AVIATION ADMINISTRATION STANDARD

Oxygen Regulators, Demand

1. Purpose.

This standard contains minimum performance and quality control standards for the manufacture of demand oxygen system regulators.

2. Classification.

The term „demand regulator“ includes all of the following classes of regulators:

(a) Straight demand regulators designed to deliver oxygen only.

(b) Diluter demand regulators designed to deliver a mixture of oxygen and air, and oxygen only.

(c) Straight demand pressure breathing regulators (straight demand regulations designed to deliver undiluted oxygen under positive pressure).

(d) Diluter demand pressure breathing regulators (diluter demand regulators designed to deliver undiluted oxygen under positive pressure).

3. Design and Construction of Regulator.

To be eligible for approval under a TSO authorization, the regulator must possess the following design and construction characteristics:

3.1 Demand regulators designed to be mounted directly upon an oxygen mask or the crewmember’s clothing or safety harness must include a flexible oxygen supply tube connecting the regulator inlet with the oxygen supply system.

3.2 Demand regulators must be constructed of materials that -

(a) Do not contaminate air or oxygen;

(b) Are not adversely affected by continuous contact with oxygen; and

(c) Are at least flame resistant.

3.3 (a) Demand regulators must be equipped with a 200 mesh screen, or equivalent filter, at the oxygen inlet port or at the oxygen inlet hose assembly.

(b) Diluter demand and diluter demand pressure regulators must be equipped with screening or not more than 100 mesh and not less than 30 mesh, or equivalent filter, at the air inlet port.

3.4 Diluter demand and diluter demand pressure breathing regulators must be provided with a means for manually selecting a delivery of undiluted oxygen. If the selection means is controlled by a rotating handle or lever, the travel must be limited to not more than 180 degrees from the „normal oxygen“ position to the „l00 percent oxygen“ position. The dilution position of the selection means must be designated „normal oxygen“ and the nondilution position must be designated „l00 percent oxygen.“ The selection means must be such that it will not assume a position between the „normal oxygen“ and „l00 percent oxygen“ positions.

3.5 Straight demand pressure breathing and diluter demand pressure breathing regulations must be designed to provide oxygen at a positive pressure of 11.0 ±3.0 inches H_2O to determine mask peripheral leakage at altitudes below which positive pressures are hereinafter required. The means of obtaining this pressure must be by push, pull, or toggle control appropriately marked to indicate its purpose.

3.6 Diluter demand and diluter demand pressure breathing regulators must incorporate means to indicate when oxygen is and is not flowing from the regulator outlet. This requirement does not apply to mask mounted regulators.

4. Performance.

Two demand regulators of each class for which approval is sought must be shown to comply with the minimum performance standards set forth in paragraphs 4.1 through 4.10 in any position which the regulators can be mounted. Tests must be conducted at ambient atmospheric conditions of approximately 30 inches Hg and 70°F., except as otherwise specified. It is permissible to correct gas flow rates and pressures to STPD conditions by computation.

4.1 (a) Demand regulators must supply the following oxygen or oxygen-air flows at not more than the specified outlet pressures. These characteristics must be displayed at all altitudes, with the oxygen supply pressure at al1 values within the design inlet pressure range, and with the diluter valve open and closed.

FLOW, LPM, ATPD:	MAXIMUM OUTLET SUCTION PRESSURE, INCHES OF WATER
20	0.40
70	.80
100	1.00

(b) Demand regulators must not flow more than 0.01 LPM, STPD, when the outlet suction pressure is reduced to 0 inches of H_2O under the conditions specified in subparagraph (a) of this paragraph.

4.2 (a) Diluter demand and diluter demand pressure breathing regulators must supply the following percentages of cylinder oxygen, by volume, at the specified atmospheric pressures and corresponding altitudes. These oxygen percentages must be delivered at regulator outlet gas flows of 20, 70, and 100 LPM ATPD, with the oxygen supply pressure at all values within the design inlet pressure range.

		Minimum percent oxygen	
Pressure mm Hg	Altitude feet	Diluter demand	Diluter demand pressure breathing
760	0	0	40
632.4	5,000	0	40
522.8	10,000	6	40
429.1	15,000	14	40
349.5	20,000	25	40
282.4	25,000	40	40
226.1	30,000	61	61
179.3	35,000	91	91
178.5	35,100	98	98
141.2	40,000	98	98
111.1	45,000	Not applicable	98

(b) Straight demand and straight demand pressure breathing regulators must supply not less than 98 percent oxygen, by volume, at all altitudes under the conditions specified in subparagraph (a) of this paragraph.

4.3 (a) Diluter demand pressure breathing regulators with the diluter valve open or closed, and straight demand pressure breathing regulators, must provide positive breathing pressure at a flow of 20 LPM, ATPD, in accordance with the following table:

ALTITUDE 1,000 FEET		POSITIVE OUTLET PRESSURE-H_2O
30	----------	0.0 +3.5 -0.0
40	----------	2.5 ±2.5
42	----------	6.0 ±1.5
44	----------	10.0 ±1.0
45	----------	12.0 ±1.0

(b) The positive pressure at 100 LPM, ATPD, must not increase by more than 0.8 inches H_2O from the positive pressure at 20 LPN, ATPD.

(c) The positive pressure at 0.01 LPM, ATPD, must not decrease by more than 0.8 inches H_2O from the positive pressure at 20 LPM, ATPD.

4.4 (a) The inward leakage of air through the regulator at sea level must not exceed 0.1 LPM, STPD, with a suction pressure of 1.0 inches H_2O applied to the outlet port, the oxygen supply inlet port sealed, and the diluter valve closed.

(b) The outward leakage of air through the regulator at sea level must not exceed 0.1 LPM, STPD, with a positive pressure of 12 inches H_2O applied to the outlet port, the oxygen supply inlet port sealed, and the diluter valve open and closed.

(c) The regulator outlet leakage must not exceed 0.01 LPM, STPD, with the regulator outlet port open and any oxygen supply pressure within the specified operating range applied at the regulator inlet port.

(d) The regulator overall leakage must not exceed 0.01 LPM, STPD, with the regulator outlet port sealed and the regulator inlet port pressurized to a value equal to the maximum specified oxygen supply pressure.

4.5 (a) Straight demand pressure breathing and diluter demand pressure breathing regulators must comply with paragraphs 4.1 through 4.4 after a negative pressure of 29 inches H_2O and a positive pressure of 24 inches H_2O are applied to the outlet port for a period of 2 minutes. The diluter valve and the regulator inlet port must be closed during these two pressure tests.

(b) Straight demand and diluter demand regulators must comply with paragraphs 4.1 through 4.4 after a negative pressure of 29 inches H_2O and a positive pressure of 12 inches H_2O are applied to the outlet port for a period of 2 minutes. The diluter valve and the regulator inlet port must be closed during these two pressure tests.

(c) Demand regulators must comply with paragraphs 4.1 through 4.4 after a positive pressure of 1.5 times the maximum oxygen supply pressure is applied to the inlet port, or to the inlet of the oxygen supply in the case of mask mounted regulators, for a period of 2 minutes. The positive pressure must be applied rapidly to simulate rapid opening of the supply valve. The diluter valve must be closed and the outlet port must be sealed during the test.

4.6 (a) Straight demand and diluter demand regulators must comply with paragraphs 4.1 through 4.4 after being subjected to a change in pressure from not less than 12.2 p.s.i.a. to not less than 2.7 p.s.i.a. in not more than one second.

(b) Straight demand pressure breathing and diluter demand pressure breathing regulators must comply with paragraphs 4.1 through 4.4 after beings subjected to a change in pressure from not less than 12.2 p.s.i.a. to not less than 2.1 p.s.i.a. in not more than one second.

4.7 Demand regulators must comply with paragraphs 4.1 through 4.4 under each condition specified in subparagraphs (a) through (d) of this paragraph with the maximum oxygen supply pressure applied to the regulator inlet:

(a) At a temperature of approximately 70° F. after being stored at a temperature of not less than 100° F. for 12 hours

(b) At a temperature of 70° F. after being stored at a temperature of not warmer than -67° F. for 2 hours.

(c) At a temperature of not less than 130° F.

(d) At a temperature of not more than 20° F.

4.8 Demand regulators must comply with paragraphs 4.1 through 4.4 after being subjected to the tests specified in sub-paragraphs (a) and (b) of this paragraph.

(a) The regulator must be vibrated along each mutually perpendicular axis for one hour (three hours total), at a frequency of 5 to 500 cps, and at a double amplitude of 0.036 inches or an acceleration of 2 „g," whichever occurs first. Mask mounted regulators need not be subjected to this vibration test.

(b) The regulator must be subjected to an endurance test of a total of 250,000 breathing cycles.

The peak breathing rate must be 30 LPM, STPD, for 200,000 cycles, and 70 LPM, STPD, for 50,000 cycles. The dilution valve must be open during one half of the 200,000 cycles and one half of the 50,000 cycles, and it must be closed during the remaining cycles. During the nonflow portion of the 30 LPM and 70 LPM breathing cycles, a back pressure of 0.5 and 1.0 inches H_2O, respectively, must be applied to the regulator outlet.

4.9 Demand regulators must be free of vibration, flutter, or chatter that will prevent compliance with paragraphs 4.1 through 4.3 when subjected to the following simulated flow conditions:

Cycles	Peak flow per cycle LPM, STPD	Back pressure at 0 LPM, inches H_2O	Diluter valve
5,000	100	1.5	Closed
5,000	100	1.5	Open

4.10 Demand regulators, when subject to accelerations up to 3 „g“ in any position, must comply with paragraph 4.1(a) except that the specified suction pressures may be exceeded by not more than 0.6 inches H_2O.

5. Maximum Environmental (Cabin) Altitude.

The minimum pressure to which the regulator has been shown to comply under paragraph 4.6(a) or (b) of this standard determines the maximum environmental (cabin) altitude of the regulator, except that the maximum environmental (cabin) altitude must not exceed the value shown in the following table:

CLASS	FEET
Straight or diluter-demand	40,000
Pressure demand	45,000

6. Quality Control.

6.1 Each production regulator must be shown to comply with paragraphs 4.1 through 4.4.

6.2 One regulator selected at random from each lot must be shown to comply with paragraphs 4.1 through 4.10. The lot size may be selected by the applicant subject to the approval of the Federal Aviation Administration on the basis of evaluation of the quality control system of the applicant (see FAR, §37.5).

7. Abbreviations and Definitions.

LPM	Liters per minute.
STPD.	Standard temperature and pressure, dry (0° C., 760 mm Hg., $PH_20=0$).
ATPD	Ambient temperature and pressure, dry (70° F.; ambient pressure; $PH_20=0$).
c.p.s.	Cycles per second.
p.s.i.a.	Pounds per square inch absolute.
g	Acceleration of gravity, 32 feet/second/second.