S-09-03

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AEROSPACE INFORMATION REPORT

AIR 847

OXYGEN EQUIPMENT FOR COMMFRCIAL TRANSPORT AIRCRAFT WHICH FLY ABOVE 45,000 FT

Issued 11-1-65
Revised

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1. PURPOSE - The purpose of this information report is to provide minimum design criteria for oxygen equipment to be used on commercial transport aircraft which fly above 45,000 ft. To separate these requirements from those for spaceplanes, the maximum flight altitude for aircraft defined by this report is limited to the maximum altitude obtainable by aircraft using air-breathing engines.

2. ASSUMPTIONS - The following assumptions have been used in the preparation of this document:

2.1 It is anticipated that decompressions may occur at some time in the operating life of aircraft capable of flying above 45,000 ft.

2.2 Upon decompression all appropriate emergency means will be activated to limit the cabin-pressure altitude to 25,000 ft.[1] Examples of emergency means are:

a. Airplane descent at a specified rate.

b. An emergency cabin pressurization system.

2.3 The emergency pressurization system, aircraft descent system, and oxygen system will have a reliability greater than that which exists in present equipment.

2.4 Passengers will not be required to wear any oxygen equipment during normal conditions.

2.5 If a decompression occurs, passengers who do not don their oxygen masks may not survive, and therefore every effort will be made to facilitate immediate donning of the masks.

2.6 Flight Crew

2.6.1 Flight crew members not at their stations are considered to be passengers who are considered separately. Cabin attendants are also considered separately.

2.6.2 All flight crew members will wear and use oxygen masks which will be connected to a suitable regulator and supplied with oxygen during the entire time at flight altitudes greater than 35,000 ft.

[1] 25,000 ft is considered to be a maximum cabin altitude for near total passenger survival for the predicted time of decompression and the descent to 14,000 ft cabin-pressure altitude.

2.6.3 Unless it is definitely established that the cabin altitude cannot exceed 40,000 ft, all flight crew members will be provided with at least torso counter-pressure per the below schedule to assure maximum effective function of the crew member. Torso pressurization should be automatic.[2]

2.6.4 Oxygen will be used by the flight crew if the cabin altitude exceeds 10,000 ft.

2.7 After decompression, the airplane will descend to 14,000 ft cabin-pressure altitude or lower as permissible by the terrain; this descent will be completed within 12 minutes after the decompression. Re-ascension to a higher altitude will not be made until the flight crew assures that all passengers have their masks on and working. The flight crew will not re-ascend above the minimum altitude necessary to permit successful completion of flight or 25,000 ft maximum cabin-pressure altitude.

3. CREW OXYGEN EQUIPMENT

3.1 The oxygen regulator should be of the diluter-demand type with automatic pressure breathing. Oxygen supply and equipment requirements should be identical to those specified in FAA CAR 4b except as noted herein:

3.2 Diluter demand operation shall provide no less than 40% total oxygen.

100% oxygen should be automatically supplied at 30,000 ft cabin pressure altitude and above. Positive pressure should be provided automatically as follows at 10 LPM ambient flow:

Positive Pressure (Inches of Water)		Cabin-Pressure Altitude (Feet)
Minimum	Maximum	
0.1	0.5	30,000
0.5	3.5	35,000
1.0	5.7	37,000
1.5	8.0	39,000
2.0	9.4	40,200
4.0	10.2	41,000
6.0	10.8	41,500
8.0	12.0	42,500
8.5	12.5	43,000
12.0	18.0	50,000 and above

[2]SAE Committee A-10, Oxygen Equipment, recognizes that cabin decompressions in excess of 25,000 ft cabin-pressure altitude can occur without loss of aircraft. In an attempt to save the maximum number of passengers, the operating flight crew are provided with torso counter pressure or equivalent to assure maximum effective crew-member function. Torso counter pressure provides balanced pressure over the torso of the crew member which minimizes the possibility of lung damage and also provides additional physiological protection.

3.3 The positive pressure loading at 135 LPM ambient flow should not decrease by more than 1.25 in. of water from the positive pressure loading at 10 LPM ambient flow and in no instance shall the mask have a negative pressure below 35,000 ft. The positive pressure loading at 0.0 ambient flow should not increase more than 1.25 in. of water above the positive pressure loading at 10 LPM ambient flow. Tests to prove operation per the above flow should be run at 10 LPM, 100 LPM, and 0.0 LPM without changing altitude at each cabin-pressure altitude noted above.

4. LIMITING DECOMPRESSION CABIN ALTITUDE

4.1 To limit the cabin altitude to 25,000 ft in the event of cabin decompression, the maximum effective area which causes decompression should be considered in design of the emergency provisions and establishing the required operating procedures. The maximum effective area should include non-catastrophic structural failures, window failures, and equipment failures which tend to increase the pressure altitude of the cabin.

4.2 In the event of a decompression, the operating flight crew should descend the airplane within the emergency descent flight envelope specified by the manufacturer. The emergency descent flight envelope should include the minimum and maximum airplane descent trajectory necessary to maintain the cabin pressure altitude at or below 25,000 ft. The descent trajectory should include at least 17 sec pilot-reaction time to initiate descent as specified by the manufacturer (the pilot may react faster, but trajectory design must allow at least 17 sec).

4.3 Limiting the cabin altitude to 25,000 ft should be demonstrated with the maximum non-catastrophic effective area capable of depressurizing the cabin.

4.4 Either pilot or co-pilot should be capable of making the emergency descent and performing all necessary descent operations independent of each other.

4.5 Warning devices stimulating at least two different senses should be used to warn the flight crew if the cabin altitude exceeds 10,000 ft cabin-pressure altitude. These warning devices should be independent of each other.

4.6 Aircraft design should provide that passengers be able to reach and don masks under any adverse acceleration or condition expected to be encountered.

5. PASSENGERS

5.1 The oxygen supply and equipment should be identical to that presently required by FAA CAR 4b for turbine-engined aircraft except as noted herein.

5.2 The partial pressure of oxygen supplied to each passenger shall provide a 10,000 ft pressure-altitude physiological equivalent through the descent profile to 14,000 ft cabin-pressure altitude.[3] Oxygen requirements for re-ascension shall be as presently required per FAA CAR 4b except the 10,000 ft pressure-altitude physiological equivalent shall be maintained.

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[3] 10,000 ft physiological equivalent is considered necessary to provide proper protection and recovery because of longer exposure times at maximum decompressed altitudes.

5.3 Oxygen should be available at each seat and each lavatory immediately upon cabin decompression. An extra oxygen outlet with mask should be provided at each left and right hand seat row and in each lavatory located so as to be readily available for use by an infant in passenger's arms.

5.4 The passengers should be instructed as to the location, method of donning and use of the mask prior to aircraft takeoff and turning on the pressurization system. If a slight pull is needed to open the valve for passengers, this should be emphasized. Passengers should be instructed to put the mask supporting harness on their heads. The instructor should demonstrate donning the mask. It should not be implied to passengers that these instructions are not necessary. Instructions should be more explicit than present practices. Masks should be automatically presented to each passenger by 10,000 ft cabin-pressure altitude. Oxygen should be automatically delivered instantly to each mask when used.

5.5 All of the following means should be provided to give passengers and cabin attendants maximum indication of the need for oxygen in the event of a decompression (see 2.6).

5.5.1 Automatic aural notification for passengers to put on oxygen masks. This should be initiated at the time the masks are presented to the passengers. The aural system must be effective at all seats and lavatories, but does not necessarily have to be effective above 25,000 ft cabin pressure altitude.

5.5.2 Automatic flashing-light sign notification for passengers to use oxygen masks. Signs should be readily visible by all passengers seated in the cabin or lavatory. This should be initiated at the time the masks are presented to the passengers.

5.5.3 Oxygen masks should be visible during normal flight. (This is to facilitate maintenance and passenger indoctrination.)

5.5.4 Instruction for use of masks should be readable by a seated passenger when the door is closed. A non-tampering note should be placed on the oxygen door, such as: "Oxygen masks are provided for your protection and safety. Please do not tamper with them."

5.6 Oxygen masks should be stowed above and forward of seated passengers' heads. This is intended to notify passengers to don their masks in the event their automatic presentation system fails, and it inhibits tampering with the oxygen system.

5.7 Passenger masks should be secured to the mask compartment door to preclude swinging excessively and to facilitate system testing and maintenance. Once deployed, the oxygen door should open wide and remain open during descent maneuvers. When opening, the oxygen door should not strike the head of a 95 percentile passenger who is using a seat belt. Presentation equipment shall not present a hazard to the seat occupant.