



AEROSPACE STANDARD

AS5722™

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Cockpit Crew Oxygen Equipment for Use from 35000 to 45000 feet Altitude

RATIONALE

A great deal has been written concerning the consequences of human exposure to high altitude caused by airplane cabin decompressions. The number of airplanes flying in the 35000 to 45000 feet (flight level FL350 to FL450) range is ever increasing; thus, there is a need for protective equipment minimum performance standards based on quantitative physiological data.

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Documents

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1. SCOPE

This document covers minimum performance standards for protective equipment used on the flight deck during rapid decompression (5 to 30 seconds) up to a maximum pressure altitude of 45000 feet. Equipment with the capability to adequately protect flight deck crew from hypoxia up to FL450 is anticipated to provide sufficient protection at lower altitudes.

1.1 Purpose

Many previous transport category airplanes and most recent models, as well as those envisioned in the future, are designed to capitalize on the flight advantages that exist above FL400. Current airworthiness requirements limit the use of oxygen equipment to this altitude unless the performance characteristics above FL400 are approved by regulatory bodies on a case-by-case basis [14CFR 25.1441(d) Airworthiness Requirements "The oxygen flow rate and the oxygen equipment for airplanes for which certification for operation above 40000 feet is requested must be approved."].

AS8027 specifies that the air/oxygen mixture at the outlet of Class E devices (designed to protect up to FL450) shall contain a minimum percentage of total oxygen by volume of 53% from ground level up to FL250. Rather than assuming inhaled flows, oxygen percentages and tracheal pressures are inherently representative of oxygenation status, as is often the case in widely used international regulations, blood oxygen saturation measurement is considered the most representative measure of oxygenation status.

This document proposes minimum performance levels for flight crew supplemental equipment when transient loss of consciousness due to sudden high-altitude exposure is associated to a catastrophic event.

NOTE: This document only addresses equipment performance for flight deck crew using quick donning masks and demand breathing oxygen regulators, which may include added features such as dilution or pressure breathing as appropriate to a given application. This document does not address hypoxia protection of passenger cabin occupants.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AIR171	Glossary of Technical and Physiological Terms Related to Aerospace Oxygen Systems
AS8026	Crewmember Demand Oxygen Mask for Transport Category Aircraft
AS8027	Crew Member Oxygen Regulators, Demand

2.1.2 EASA Publications

Available from European Union Aviation Safety Agency, Konrad-Adenauer-Ufer 3, D-50668 Cologne, Germany, Tel: +49 221 8999 000, www.easa.europa.eu.

2.1.2.1 Airworthiness Requirements

CS-23 Certification Specifications for Normal, Utility, Aerobatic and Commuter Aeroplanes

CS-25: Certification Specifications for Large Airplanes

2.1.2.2 Operational Requirements

Commission Regulation (European Union) No 965/2012, of 5 October 2012: Requirements And Administrative Procedures Related To Air Operations

2.1.2.3 Equipment Standards

European Technical Standard Order (ETSO):

ETSO-C78: Crewmember Demand Oxygen Mask. European Aviation Safety Agency

ETSO-C89A: Oxygen Regulators, Demand. European Aviation Safety Agency

2.1.3 FAA Publications

2.1.3.1 Airworthiness Requirements

14 Code of Federal Regulations (CFR) § 23: Airworthiness Standards, Normal, Utility, Acrobatic and Commuter Category Airplanes - Available on the Electronic Code of Federal Regulations (eCFR) website: <https://ecfr.io/Title-14/Part-23>

14 CFR § 25: Airworthiness Standards, Transport Category Airplanes, Federal Aviation Administration - Available on the Electronic Code of Federal Regulations (eCFR) website: <https://ecfr.io/Title-14/Part-25>

Federal Aviation Administration: Interim Policy on High Altitude Cabin Decompression (Reference Amendment 25-87), Memo No.: ANM-03-112-16 - Regulatory Reference: § 25.841(a), March 24, 2006

2.1.3.2 Operational Requirements

14 CFR § 91: General Operating and Flight Rules, Federal Aviation Administration

14 CFR § 121: Operating Requirements: Domestic, Flag, and Supplemental Operations, Federal Aviation Administration

14 CFR § 135: Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons On Board Such Aircraft, Federal Aviation Administration

2.1.3.3 Equipment Standards

Technical Standard Order (TSO):

TSO-C78A: Crewmember Demand Oxygen Mask. DOT, FAA, Airplane Certification Services, Washington, DC

TSO-C89A: Oxygen Regulators, Demand. DOT, FAA, Airplane Certification Services, Washington, DC

2.1.4 Other Publications

Gradwell, D. (2016), Hypoxia and Hyperventilation. In D. Gradwell & D. Randford (Ed.), *Ernsting's Aviation and Space Medicine*, 5th edition (pp 49-65), CRC Press

2.2 Abbreviations and Definitions

2.2.1 Abbreviations

14CFR Code of Federal Regulations

CS Certification Specification

FAA Federal Aviation Administration

FL Flight Level

EASA European Union Aviation Safety Agency

DOT Department of Transportation

TSO Technical Standard Order

ETSO European Technical Standard Order

HST Human Subject Testing

2.2.2 Definitions

DECOMPRESSION (AIR171): Loss of pressurization of an airplane cabin or cockpit.

DECOMPRESSION TIME: Time for the cabin pressure altitude to meet airplane flight altitude post-decompression.

RAPID DECOMPRESSION (AIR171): A rapid reduction of air pressure inside an airplane, reaching a new static condition in balance with the external pressure. Generally, any decompression which results in flying debris, fogging, and rapid temperature drop associated with the Joule-Thompson effect. For this document, rapid decompression is further defined as occurring within 5 to 30 seconds.

POSITIVE PRESSURE BREATHING (PPB): Term used to characterize an oxygen system that provides breathing gas at higher than ambient pressures.

ARTERIAL BLOOD OXYGEN SATURATION (S_{aO_2}): Typically expressed as a percentage of binding capacity of total hemoglobin of circulating blood, often denoted as S_pO_2 if assessed by pulse oximetry.

MEAN ALVEOLAR OXYGEN PARTIAL PRESSURE (P_{AO_2}): Product of oxygen concentration and pressure in the lungs (including PPB), leading to oxygen diffusion into the blood and resulting in S_{aO_2} .

3. DECOMPRESSION

At the flight altitudes addressed in this document, exposure times will be relatively limited. The scenario of the cabin pressure reaching FL450 inherently represents a pressurization failure requiring an immediate emergency descent as rapidly as circumstances permit. The historic and regulatory perspective considers this a decompression from a cabin pressure altitude of 8000 feet, up to a worst-case scenario of FL450. This transition may occur suddenly or within a short timeframe up to 30 seconds.