

Oxygen Cylinder Installation Guide

RATIONALE

The revision of this document considers information regarding packaging and transportation as provided by recent published AIR5742 and an update of requirements related to safety precautions for oxygen cylinder installation.

TABLE OF CONTENTS

1.	SCOPE.....	2
2.	REFERENCES.....	2
2.1	Applicable Documents	2
2.1.1	SAE Publications.....	2
2.1.2	Other Publications.....	2
2.2	Definitions	3
3.	REQUIREMENTS	3
3.1	Compatibility with Aircraft Environment	3
3.1.1	Pre-Design Analysis.....	3
3.1.2	Design Verification	3
3.2	Design Objectives and Installation Precautions	4
3.2.1	Airworthiness Requirements.....	4
3.2.2	Design Objectives	4
3.2.3	Installation Precautions.....	5
3.3	Testing	5
3.4	Maintenance and Servicing.....	5
3.4.1	Refilling Cylinders	5
3.4.2	Hydrostatic Testing.....	6
3.4.3	Cylinder Inspection.....	6
3.4.4	Leakage Testing.....	6
3.5	Transportation and Handling.....	6
4.	QUALITY ASSURANCE	7
5.	NOTES.....	7

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1. SCOPE

This document provides guidance for oxygen cylinder installation on commercial aircraft based on rules and methods practiced in aerospace industry and applicable in other associations.

It covers considerations for oxygen systems from beginning of project phase up to production, maintenance, and servicing.

The document is focused on requirements regarding DOT approved oxygen cylinders. However, its basic rules may also be applicable to new development pertaining to use of such equipment in an oxygen environment.

For information regarding oxygen cylinders itself, reference should be made to AIR825/12 also.

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 724-776-4970 (outside USA), www.sae.org

AIR825/12	Oxygen System Integration and Performance Precautions
AIR825/13	Guide for Evaluating Combustion Hazards in Aircraft Oxygen Systems
AIR5742	Packaging and Transportation of Oxygen Equipment
AS1046	Minimum Standard for Portable Gaseous, Oxygen Equipment
AIR1059	Transfilling and Maintenance of Oxygen Cylinders
AS1219	Aircraft Oxygen Replenishment Coupling for Civil Transport Aircraft (Design Standard)
AS8010	Aviator's Breathing Oxygen Purity Standard

2.1.2 Other Publications

ISO 9001 Quality systems - Model for quality assurance in design/development, production, installation and servicing

Federal Specification RR-C-901C, which identifies Oxygen Cleaning requirements

FAA Order 8000.40C - Maintenance of Pressure Cylinders in Use as Aircraft Equipment

Compressed Gas Association Publications CGA C-1, C-6, C-6.2 and C-6.8, CGA-540, CGA-577, CGA-701

European Industrial Gases Association (EIGA) – External Prefill Inspection for Composite Cylinders, IGC 131/05/E

MIL-PRF-27210, "Oxygen, Aviator's Breathing, Liquid and Gas"

GENERAL COMMENT: The DOT specifications are contained in the Code of Federal Regulations, Transportation, 49 within Parts 100 to 199 and any Special Permit granted for example by the Department of Transportation (DOT) for composite cylinders

2.2 Definitions

COMPOSITE CYLINDER: Pressure vessel consisting of a gas tight metal (e.g., aluminum) container reinforced by filament material as fiberglass, kevlar, carbon, or hybrid fibers.

HYDROSTATIC TEST: Periodic pressure test within the life of the component to verify its serviceability.

OXYGEN CYLINDER: Pressure vessel to store breathing gas (oxygen) under high pressure. Such equipment is available in various sizes and designed according to DOT specifications.

3. REQUIREMENTS

3.1 Compatibility with Aircraft Environment

3.1.1 Pre-Design Analysis

Prior to the design of oxygen cylinder installation an analysis should be made to determine that the installation will be compatible with conditions on the aircraft during operation, servicing and maintenance.

During oxygen system definition one of the most important issues influencing the overall system architecture is the location of the oxygen source in an aircraft.

System availability and aircraft safety are dependent to a high degree on careful selection of oxygen cylinder location.

The purpose of the analysis shall be to show that potential hazards are minimized to the aircraft and its occupants which could result from the installation, of the system or system failure effects.

Prior to system design the oxygen cylinder installation should be evaluated by a hazard, particular risk and or zonal analysis, covering repercussions of:

- a. Uncontained engine burst
- b. Compatibility with surrounding systems (e.g., electrical power, hydraulics, fuel, hot air, etc.)
- c. Cylinder burst should not lead to a Hazardous or Catastrophic Effect
- d. Consequences of oxygen leakage, in particular that the installation area is sufficiently ventilated to ensure the oxygen concentration will not exceed 25%.

NOTE: The importance of area ventilation is to ensure that oxygen concentration greater than 25% will not be exceeded due to cylinder leakage.

- e. Structural damage during crash landing
- f. Flight loads
- g. Vibration and acceleration
- h. Removal and reinstallation of oxygen cylinders

3.1.2 Design Verification

Subsequent to the design of oxygen cylinder installation a review should be made to confirm that assumptions and targets established as a result of the pre design analysis have been considered and can be accomplished.

3.2 Design Objectives and Installation Precautions

3.2.1 Airworthiness Requirements

The design for oxygen cylinder installation including fixation in the aircraft should comply with FAR/CS Airworthiness Requirements of FAA/EASA, mainly:

- a. 25.561 Emergency Landing Conditions
- b. 25.601 Design and Construction (General)
- c. 25.603 Design and Construction (Material)
- d. 25.611 Design and Construction (Accessibility Provisions)
- e. 25.869 Fire Protection Systems
- f. 25.899 Electrical Bonding and Protection Against Lightning and Static Electricity
- g. 25.903 Engines (Turbine Engine Installation)
- h. 25.1301 Equipment (Function and Installation)
- i. 25.1309 Equipment (Equipment System and Installation)
- j. 25.1441 Oxygen Equipment and Supply
- k. 25.1453 Protection of Oxygen Equipment from Rupture
- l. 23.1451 Fire Protection for Oxygen Equipment (applicable to aircraft certified as per FAR/CS 23 Requirements)

3.2.2 Design Objectives

Design objectives as stated in the following will be applicable to current DOT type steel and composite cylinders. With regards to development of new pressure vessel technology, based on different materials, the objectives may be completed and advanced testing methods may also be taken into account.

- 3.2.2.1 Oxygen cylinder(s), associated lines and equipment shall be protected against high temperatures and shall not be installed in designated fire zones.
- 3.2.2.2 The support(s) of the oxygen cylinder(s) shall be designed to withstand the flight, landing and crash loads.
- 3.2.2.3 The installed oxygen cylinder(s) and associated equipment shall not be ruptured by deformation of the fuselage in case of landing with retracted nose landing gear.
- 3.2.2.4 Orientation of the oxygen cylinder(s) shall be such, that the pressure gauge is readable without removing the cylinder(s) from attachments and connections to lines.
- 3.2.2.5 Sufficient ventilation of the installation area should be ensured in case of leakage (Reference AIR825/13).
- 3.2.2.6 Maintenance on other systems should not necessitate the removal of oxygen cylinders, their supports or associated components.
- 3.2.2.7 Access to oxygen cylinder(s) for checks, maintenance and removal/reinstallation should not require disassembling of other systems.

3.2.3 Installation Precautions

The installation on the aircraft should ensure that precautions have been realized as following:

- a. Proximity to combustibles, moving aircraft parts and electrical wiring/equipment shall comply with requirements of AIR825/12 and AIR825/13.
- b. Unambiguous information (e.g., placards) shall be provided regarding the location of the equipment, handling, accessibility and a caution that oxygen equipment needs particular attention.

3.3 Testing

Leakage testing and function checks related to equipment, interconnection lines, and oxygen cylinder(s) should be performed at intervals required by the maintenance program for the aircraft type.

The Department of Transportation (DOT) specifies hydrostatic test requirements and service life limitations for the various types of cylinders used in aircraft oxygen systems. The date of manufacture and hydrostatic test dates are stamped on the shoulder of steel cylinders. The date of manufacture is included on the cylinder label of composite cylinders; subsequent hydrostatic test dates are shown on retest labels which are attached to the composite overwrap. The not to be exceeded hydrostatic test dates are:

- a. A maximum of five years for steel (3AA) cylinders, refer to CGA pamphlet C-6
- b. A maximum of three years for steel (3HT) or five years for composite cylinders FRP TYPE FC (e.g., SP-8162), also refer to CGA pamphlet C-6.8.
- c. As per DOT exemption.

Cylinders may not be refilled or topped off unless they have a current hydrotest.

Steel cylinders (3AA) have an unlimited service life, provided they pass the periodic hydrotest. Steel (3HT) cylinders have a 24 year service life or 4380 pressurizations, and composite cylinders FRP TYPE FC (e.g., E-8162) have a 15 year service life, provided they pass the periodic hydrotest and / or comply with appropriate DOT exemption.

If a cylinder is to be removed for maintenance but not tested, it should not be vented completely. Some residual pressure, approximately 0.2 MPa (29 psi), shall remain, so that the cylinder will not be contaminated.

NOTE: Other types of cylinders may have different hydrostatic tests and service lives, refer also to CGA pamphlet C-6.2.

3.4 Maintenance and Servicing

3.4.1 Refilling Cylinders

The cylinders may be filled or recharged by adding oxygen to the cylinder when installed on the aircraft (transfilling) or the cylinder may be removed for remote recharging and reinstallation into the aircraft.

3.4.1.1 On-Aircraft Transfilling: The cylinders will be refilled as per the aircraft manufacturers procedures and AIR1059.

Oxygen cylinders should only be serviced with oxygen per AS8010 or MIL-PRF-27210 and consideration should be given to the use of an inline filter to prevent metal particle ingestion.

3.4.1.1.1 Transfilling Equipment: Systems designed for transfilling shall have external access to the filling port. The filling port shall conform to AS1046, AS1219 or CGA Connection No. 540. For each cylinder, there shall be a contents indicator or gage that shows the pressure or contents during refilling. Adequate protection shall be provided to prevent damage or contamination to the fill port before, during, and after transfilling.