



AEROSPACE INFORMATION REPORT

AIR1059™**REV. G**

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Superseding AIR1059F

Oxygen Cylinder Quality, Serviceability, Maintenance Transfilling, and Marking

RATIONALE

The main purpose for updating this document is to adapt to a broader configuration of cylinder sizes. In particular, sections 4.6 and 6.3 are refined for smaller cylinder sizes configurations.

1. SCOPE

This document provides guidance concerning the maintenance and serviceability of oxygen cylinders beginning with the quality of oxygen that is required, supplemental oxygen information, handling and cleaning procedures, transfilling, and marking of serviced oxygen assemblies. This document attempts to outline in a logical sequence oxygen quality, serviceability, and maintenance of oxygen cylinders. Content of this document can also be used for refilling oxygen cylinders while installed on aircraft, directly or through an intermediate charging port.

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: 1-877-606-7323 (U.S. and Canada only) or 1-724-776-4970 (outside U.S. and Canada), www.sae.org.

AIR4071	Lubricants for Oxygen Use
AIR5742	Packaging and Transportation of Oxygen Equipment
ARP1176	Oxygen System and Component Cleaning
AS8010	Aviator's Breathing Oxygen Purity Standard

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Documents

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2.1.2 CGA Publications

Available from Compressed Gas Association, 8484 Westpark Drive, Suite 220, McLean, VA 22102, Tel: +1 703-788-2700, www.cganet.com.

C-6	Standards for Visual Inspection of Steel Compressed Gas Cylinders
C-6.1	Standard for Visual Inspection of High-Pressure Aluminum Alloy Compressed Gas Cylinders
C-6.2	Standard for visual Inspection and Requalification of Fiber Reinforced High Pressure Cylinders
P-1	Standard for Safe Handling of Compressed Gases in Containers
P-2.5	Standard for the Transfilling of High-Pressure Gaseous Oxygen Used for Respiration
P-15	Filling of Industrial and Medical Nonflammable Compressed Gas Cylinders
P-38	Guidelines for Devalving Cylinders
V-1	Standards for Compressed Gas Cylinder Valve Outlet and Inlet Connections

2.1.3 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9500, www.astm.org.

ASTM G63	Standard Guide for Evaluating Nonmetallic Materials for Oxygen Service
ASTM G94	Standard Guide for Evaluating Metals for Oxygen Service

2.1.4 ISO Publications

Copies of these documents are available online at www.iso.org/store.

ISO 7866	Gas cylinders - Refillable seamless aluminium alloy gas cylinders - Design, construction and testing
ISO 8573-1	Compressed air - Part 1: Contaminants and purity classes
ISO 9809-1	Gas cylinders - Design, construction and testing of refillable seamless steel gas cylinders and tubes - Part 1: Quenched and tempered steel cylinders and tubes with tensile strength less than 1100 MPa
ISO 9809-2	Gas cylinders - Design, construction and testing of refillable seamless steel gas cylinders and tubes - Part 2: Quenched and tempered steel cylinders and tubes with tensile strength greater than or equal to 1100 MPa
ISO 9809-3	Gas cylinders - Design, construction and testing of refillable seamless steel gas cylinders and tubes - Part 3: Normalized steel cylinders and tubes

2.1.5 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

MIL-PRF-25567	Leak Detection Compound, Oxygen Systems
MIL-PRF-27210	Aviator's Breathing Oxygen, Liquid and Gas

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Information Report.

2.2.1 Code of Federal Regulations (CFR) Publications

Copies of these documents are available online at www.ecfr.gov.

49 CFR § 180.209 Requirements for Requalification of Specification Cylinders

49 CFR § 173.301 General Requirements for Shipment of Compressed Gases and other Hazardous Material in Cylinders UN Pressure Receptacles and Spherical Pressure Vessels

49 CFR § 173.302 Filling of Cylinders with Non-Liquefied (Permanent) Compressed Gases or Absorbed Gases

2.2.2 OSHA Publications

Available from Occupational Safety and Health Administration, 200 Constitution Avenue NW, Washington, D.C., 20210, Tel: 1-800-321-6742, www.osha.gov.

OSHA 1910-253 Oxygen Fuel Gas Welding and Cutting

2.2.3 U.S. Department of Transportation Publications

Available from U.S. Department of Transportation, 1200 New Jersey Avenue SE, Washington, D.C., 20590, Tel: 855-368-4200, www.transportation.gov.

Any Applicable U.S. DOT Special Permits

DOT-SP 8162 PHMSA (example of a special permit for structural composites)

3. INTRODUCTION

Recharging of portable and fixed oxygen cylinders by the unauthorized user is a practice both condemned and discouraged by the Compressed Gas Association (CGA) and the National Fire Protection Association (NFPA). Their condemnation is based on the firm conviction of the majority of the Association members that “transfilling” an oxygen cylinder by “unqualified” personnel is basically unsafe and must not be performed. In the United States, the DOT regulations govern the ownership of the cylinder and authorization to fill it. In Canada, Transport Canada Transportation of Dangerous Goods Regulations control the filling of cylinders (refer to CGA Pamphlet P-1). In other countries, other authorities and regulations may apply. All personnel assigned to transfilling must be trained and qualified in the inherent hazards of high-pressure aviation oxygen and knowledgeable in this equipment.

WARNING: Improper use, handling, or maintenance of oxygen equipment may result in serious injury or death.

Oxygen equipment is to be serviced including transfilling only in accordance with applicable written service procedures available from the original equipment manufacturer and, in the case of transfilling, in compliance with CGA Pamphlet P-2.5 and with local regulations. Only service technicians trained in the inherent hazards of high-pressure aviation oxygen and knowledgeable in this equipment may service this equipment.

Commercial airlines, aircraft manufacturers, and aircraft service stations have been involved in, and will continue to follow, the practice of filling the portable oxygen units and fixed oxygen cylinders in commercial and general aviation. A standardized procedure should be established for charging high-pressure oxygen cylinders in those aviation facilities which are required by circumstances to perform oxygen cylinder filling. This document starts with an overview of oxygen cylinder requirements.

4. OXYGEN COMPOSITION REQUIREMENTS

4.1 Oxygen Quality

All oxygen gas purchased or manufactured for filling aviator's breathing oxygen cylinders shall comply with aviator's breathing oxygen per AS8010 or Military Specification MIL-PRF-27210. When oxygen is purchased for this purpose, the oxygen manufacturer's delivery ticket shall bear a certification that oxygen purity conforms to the above specifications and prescribed tests under the above specifications have been performed prior to delivery. Records of such delivery shall be maintained by the cylinder filler for a period of 5 years, minimum.

4.2 Test Procedure

Chemical tests for various gas concentrations have evolved and been replaced by the use of calibrated gas analyzers, and these are the preferred methods due to ease of operation. The chemical methods are still an acceptable method and have been retained in this document for historical reference. All chemical tests shall be made with analytical reagent grade chemicals and distilled water. Samples taken in accordance with Section 5 shall be tested: for purity, using a method approved by the procuring activity such as 4.3; for odor, in accordance with 4.5; for moisture, in accordance with 4.4; for pressure, in accordance with 4.6; and for leakage, in accordance with 4.8.

4.3 Purity

Oxygen gas in serviced cylinders shall contain not less than 99.5% oxygen by volume, when tested. Samples taken for test shall be tested for conformance to AS8010 or MIL-PRF-27210.

The test for oxygen concentration has evolved from chemical analysis to the use of calibrated oxygen analyzers. The use of an oxygen analyzer that has a certified calibration within due date is recommended as an acceptable means to determine the level of oxygen concentration. The chemical analysis method, while still an acceptable method of analysis, is provided as historical reference.

Place a sufficient quantity of mercury in a 100 cm³ calibrated gas measuring burette provided with a two-way stopcock and a two-way outlet and properly connected with a liquid leveling tube. Connect one of the outlet tubes of the burette with a gas pipette of suitable capacity. Place in the pipette a coil of copper wire which extends to the uppermost portion of the bulb and add about 125 cc of ammonium chloride-ammonium hydroxide test solution (made by mixing equal volumes of water and 27% concentrated ammonia; then saturate with ammonium chloride). Draw the liquid (free from air bubbles) through the capillary opening connection and stopcock opening in the burette by reducing the pressure in the burette tube and opening the stopcock controlling connection with the gas pipette. Then close the stopcock.

Having completely filled the burette, the other stopcock opening, and the other intake tube with mercury, draw into the burette exactly 100 cc of oxygen by reducing the pressure in the tube. Close the stopcock.

Increase the pressure on the oxygen in the burette tube and open the stopcock controlling the connection with the gas pipette. Force the entire volume of gas into the pipette. Close the stopcock, and rock the pipette gently, providing frequent contact with the liquid, gas, and copper spiral. At the end of 15 minutes, most of the gas will have been absorbed by the liquid. At this time, to facilitate absorption of the last portion of the oxygen, draw some of the liquid into the burette tube, and force the residual gas back upon the surface of the liquid in the gas pipette. Again, rock the pipette until no further diminution in the volume of the gas occurs. Draw the residual gas, if any, into the burette tube, and measure its volume. The volume of gas remaining undissolved shall not exceed 1/2 cc. The ammonium chloride-ammonium hydroxide solution should be used for leveling purposes if desired.

4.4 Moisture

The moisture content shall be determined by use of an electrolytic type of moisture meter or other method or equipment satisfactory for the purpose.

The oxygen gas in serviced cylinders shall contain no more than 0.02 mg of water per liter of gas at 21 °C (70 °F) and 760 mm Hg (1 MPa or 1013 mbar). This level of moisture is equivalent to 25 ppm by volume or a -53 °C (-64 °F) dew point.

4.5 Odor

Each cylinder serviced, as well as those selected as specified in Section 5, shall be subjected to the following test: The cylinder valve shall be slowly opened enough to allow a small amount of oxygen to flow. No smell should exist since pure oxygen is odorless and tasteless; cylinders received for refill which have an odor present shall be visually inspected internally, cleaned, and dried before filling (see 4.9). Filled cylinders having an odor shall be rejected.

4.6 Filling Pressure

The cylinder shall be filled to the pressure at 21 °C (70 °F) as required by the markings on the cylinder or required by the equipment manufacturer and indicated by a decal, label, or other means. On steel cylinders, the maximum filling pressure is stamped on the shoulder of the cylinder; as for example, DOT 3AA 1800 signifies a filling pressure of 1800 psig (12.4 MPa). On fully wrapped composite cylinders, the maximum filling pressure is marked on a label imbedded in the overwrap. For example, a marking such as DOT SP-XXXX 1850 signifies a filling pressure of 1850 psig (12.76 MPa). The actual cylinder pressure charge shall be determined by a calibrated lab type gauge with an accuracy of $\pm 5\%$ of the filling pressure.

WARNING: Cylinders should be refilled slowly enough (see hereafter) to **avoid heat of rapid compression**. Sufficient time must be allowed for the gas temperature to stabilize to 21 °C (70 °F) before checking the pressure to avoid needing to recheck pressure after cool-down of cylinder (1 MPa = 10 bar). It is suggested that the operator consults with the cylinder manufacturer for safe maximum temperature ratings prior to any cylinder refill.

Maximum refilling pressure: rate can be adapted to the context. A maximum rate of 1.4 MPa (200 psi) per minute is the usual practical value. Higher rates may be acceptable depending on the exact configuration and means certified by the operator (i.e., optimized for various volumes, tank material, temperature-controlled means...).

Special attention should be given when refilling an empty cylinder because the pressure relation (final/initial) is higher, then the adiabatic compression will be higher too. Specifically for smaller cylinders, refilling rates lower than 200 psi per minute shall be necessary to avoid exceeding the maximum allowable temperatures.

4.7 Pressure Gauge Accuracy

Cylinders which have pressure gauges as an integral part of the valve assembly shall be tested as follows. Check that cylinder gauge reading is within 3448 hPa (50 psi) of the gauge reading on the refilling equipment. Inaccurate gauges should be replaced with gauges of the same equipment manufacturer's part number. Only gauges marked "use no oil" which have been cleaned for oxygen service should be used.

NOTE: On some cylinder assemblies incorporating an integral pressure reducer, a filler valve is used which has a pressure drop of 1724 hPa (25 psig) or higher psig. This type of assembly requires that the gauge be removed for test or an allowance be made for the pressure drop.

4.8 Leakage

Each filled cylinder shall be tested for leakage. Various acceptable methods are available:

- Either by brushing an approved oxygen compatible leak check solution (refer to MIL-PRF-25567) over the cylinder and all portions of the valve, or
- By submerging in water, the cylinder and those portions of the valve and gauge which will not be damaged by submersion, or
- By checking pressure decay with time (if the cylinder is equipped with a pressure gauge or transducer and by giving caution to the measurement accuracy and temperature correction due to ambient temperature variation), or
- By weight loss measurement with time.