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AEROSPACE INFORMATION REPORT

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Superseding AIR1059B, AS1065

(R) Oxygen Cylinder Quality, Serviceability, Maintenance Transfilling and Marking

RATIONALE

This standard has been extensively revised to combine AS1065 and AIR1059 into one comprehensive report intended to provide practices and guidance to the most recent standards. Where appropriate existing standards are added as references.

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.

2. REFERENCES

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 the 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 Applicable Documents

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.

AS8010 Aviator's Breathing Oxygen Purity Standard

ARP1176 Oxygen System and Component Cleaning and Packaging

AIR822 Oxygen Systems for General Aviation

AIR5742 Packaging and Transportation of Oxygen Equipment

AIR4071 Lubricants for Oxygen Use

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SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AIR1059C

2.1.2 CGA Publications

Contact information for the Compressed Gas Association (CGA) Documents, 4221 Walney Road, 5th floor, Chantilly, VA 20151

P-1 Safe Handling of Compressed Gas Cylinders

P-2.5 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

C-6 Standards for Visual Inspection of Steel Compressed Gas Cylinders

C-6.2 Guidelines for visual Inspection and Requalification of Fiber Reinforced High Pressure Cylinders

2.2 Other References

2.2.1 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, http://assist.daps.dla.mil/quicksearch/.

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

MIL-PRF-25567 Leak Detection Compound, Oxygen Systems

3. INTRODUCTION

Recharging of small portable 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 (ref. 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 knowledgable 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, Transfilling of High Pressure Gaseous Oxygen Used for Respiration, (see reference section) and with local regulations. Only service technicians trained in the inherent hazards of high pressure aviation oxygen and knowedgable in this equipment may service this equipment.

It is a matter of record that the commercial airlines, aircraft manufacturers, and aircraft service stations have been involved in, and will continue to follow, the practice of filling the small portable oxygen units and fixed oxygen cylinders in commercial and general aviation. This practice has developed over the last forty years and, while there have been occasional accidents, the practice will not be stopped. The lost time, paper work, cost, etc., involved in sending cylinders to a commercial gas supplier is economically unsound. As this is the case, it logically follows that 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. 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 AS 8010 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 method 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 5.0 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 percent oxygen by volume, when tested. Samples taken for test shall be tested for conformance to SAE AS8010, Aviator's Breathing Oxygen Purity Standard or MIL-PRF-27210 Aviator's Breathing Oxygen Liquid & Gas

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 a historical reference [Place a sufficient quantity of mercury in a 100 cubic centimeter 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 of 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 moisture meter or other method or equipment satisfactory for the purpose.

The oxygen gas in serviced cylinders shall contain not more than 0.02 milligrams 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 5.0 shall be subjected to the following test: The cylinder valve shall be cracked and the escaping gas smelled. 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 section 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 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 ±5% of the filling pressure.

NOTE: Cylinders should be refilled slowly enough (less than 2.1 MPa (300 psi) per minute) to avoid heat of rapid recompression. Sufficient time must be allowed for the gas temperature to stabilize to 21 °C (70 °F) before checking the pressure to avoid need to recheck pressure after cool-down of cylinder. (1MPa = 10 Bar)

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 either by brushing an approved oxygen compatible leak check solution (see reference 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. Continued bubbling indicates leakage and is cause for rejection. This must be distinguished from bubbling caused by the escape of air entrapped in crevices and corners. Also a test shall be conducted with outlet capped and "valve opened". Any leakage, visible within 5 minutes, around valve stem or packing gland is cause for rejection. If cylinder valve is equipped with a gauge, check for leakage at gauge-valve connection and in gauge body.

Cylinders, and valves installed therein, shall not leak when tested as specified above.

4.9 Inspection, Cleaning and Drying

Internal inspection, cleaning and drying of cylinders shall be accomplished whenever a cylinder has been completely emptied and the valve left open with questionable exposure or due to the presence of odors or moisture. It is recommended that these procedures be performed by a DOT qualified retest station with the facilities and equipment to effectively perform these tasks or by following the information contained in the equipment manufacturer's Component Maintenance Manual (CMM). The following is provided as a guideline only and may not be a complete procedure. The valve or regulator must first be removed per procedures outlined in CGA Pamphlet P-38, Guidelines for Devalving Cylinders. Visually inspect the inside of the cylinder for any signs of corrrosion. If present, send cylinder to a DOT qualified retest station where the proper media can be used to remove the corrosion and verify the cylinder is still suitable for the intended service. A cleaning station may clean the cylinder using a stainless steel tube to inject warm, approximately 26.7 °C (80 °F),flushing or cleaning agent into the inverted cylinder for 3 minutes and allow the cylinder to drain for one minute. NOTE: Any cleaning process must be verified for effectiveness (see ARP1176, Oxygen System and Component Cleaning and Packaging). Drying is to be performed by heating in an oven or water bath while simultaneously maintaining a vacuum in the inside of the cylinder, or by passing hot, approximately 82 °C (180 °F), dry, oil free air or nitrogen through the cylinder for one minute. After the drying process has been completed and the valve or regulator replaced, each cylinder should be evacuated by drawing a vacuum of 686 mm of mercury (27 inches of mercury) for a minimum period of 30 minutes prior to the oxygen refill procedure. Each cylinder requiring drying shall have the oxygen tested for moisture content after filling. If the valve or regulator is not immediately replaced the cylinder must be suitably capped to maintain the cleanliness.

4.10 Compliance Responsibility

The filling agency is responsible for assuring that prior to the cylinder being recharged it complies with applicable DOT and ICC regulations even when the cylinder being recharged is mounted in a fixed part of the aircraft oxygen system. Confirm the cylinders are within working pressure, hydrostatic test required date and visually inspect the cylinder following CGA guidelines as outlined in the appropriate CGA pamphlet, C-6, Standards for Visual Inspection of Steel Compressed Gas Cylinders and C-6.2 Guidelines for visual Inspection and Requalification of Fiber Reinforced High Pressure Cylinders. See also Section 8.8 Containers.

5. SAMPLING, FILLING, INSPECTION AND TEST PROCEDURES

5.1 The cylinder filler is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the cylinder filler may utilize his/her own or any other inspection facilities and services acceptable to the buyer. Records of the cylinder filling, cylinder examination and tests shall be kept complete and available for 5 years. The buyer reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that gas and cylinders conform to prescribed requirements.

5.2 100 Percent Inspection Requirements

Each cylinder serviced must be inspected as follows: for odor, per 4.5; for filling pressure, per 4.6; for leakage 4.8 and for pressure gauge accuracy, per 4.7.

5.3 Purity Sampling Requirements

Each set of cylinders charged on a manifold at one time, or charged from the same bank of supply cylinders, shall make up one lot. The number of samples shall conform to Table 1 for lot size or fraction thereof.

NOTE: An operator, who services cylinders on aircraft, would sample a cylinder charged from his/her supply bank whenever a cylinder in his/her supply bank is changed.

TABLE 1 - INSPECTION SAMPLES[1]

Number of Sampling Cylinders	Lot Size (Total Number of Cylinders Being Charged)
1	1 - 10
2	11 - 40
3	41 - 70
4	71 & Up

[1] Each cylinder selected for testing shall have approximately 28.3 liters (1 cubic foot) NTPD of gas withdrawn before sampling for tests.

5.3.1 In cases where gaseous oxygen is compressed into cylinders from the vaporization of liquid oxygen, the following alternate procedure for sampling shall be followed: From the initial filling of the liquid storage each day, or upon addition of quantities of liquid oxygen to the system, cylinders from the first manifold charged shall be sampled in accordance with Table 1. The last cylinder filled in each group should also be sampled to check for boil-off of previously frozen out contaminants.

5.3.2 Samples taken shall be tested for conformance to Paragraph 4.3 and to AS8010, Aviator's Breathing Oxygen Purity Standard. Non-conformance of one sample will be grounds to reject all of the cylinders in that lot. The entire lot is to be emptied cleaned and refilled as required by the nature of the non-conformance.

6. GENERAL HIGH PRESSURE INFORMATION

6.1 Pressures: Gases under pressure present a potential hazard in the form of stored energy. Accidents are caused when this energy is improperly controlled or admitted to equipment which is not designed for the pressures encountered. In general, the available energy increases as the pressure increases. Compressed oxygen is available in DOT (Department of Transportation) approved cylinders at pressures up to 18.20 MPa (2640 psig). See also CGA Pamphlet P-1, Safe Handling of Compressed Gas Cylinders.

6.2 Oxygen is an oxidizing gas and, in itself, is not flammable. Oxygen does, and is required to, support combustion. High oxygen concentrations can accelerate the combustion of flammable materials even to the point of explosion. Almost all materials are combustible in the presence of pure oxygen and pure oxygen under high pressure will enhance this property further. Spontaneous combustion of oil and other organic materials may occur in the presence of oxygen- rich environments, particularly when heat is also involved. Therefore, all equipment intended for oxygen enriched and breathing oxygen service must be free of oil and grease and clean for oxygen service. If lubricants are needed, reference AIR4071, Lubricants for Oxygen Use.

6.3 Open valves on compressed oxygen cylinders and on valve leading into oxygen systems slowly and carefully. The compression of a gas during pressurization of a system results in the release of energy in the form of heat. Should compression occur quickly in a container or a closed section of piping, the heat generated can cause a sharp rise in localized temperature. If an adiabatic type compression is considered here, then the theoretically possible temperature rise is a function of the .286 power of the absolute pressure ratio.

Example (in english units): Charging an empty cylinder to 1850 psig (12.76 MPa).

$(1864.7 \text{ psia}/14.7 \text{ psia})^{.286} = 4.0 = (460 + T)/(460 + 70)$

$T = 1657\ ^\circ F$

Example (in Metric units): Charging a cylinder to 12.76 MPa (1850 psig)

$(12.86 \text{ MPa absolute}/.10138 \text{ MPa})^{.286} = 4.0 = (273.2 + T)/(273.2 + 21.1)$

$T = 902.8\ ^\circ C$

This temperature rise, in a pure oxygen system, can be high enough to cause ignition of oil, grease, solvents, and/or such materials as dust, lint, metal chips, or many organic materials.

Oxygen flowing at high velocity through piping systems can propel particles of foreign material with such force that friction or impact can raise the particles' temperature to the ignition point. This is particularly true where a high degree of cleanliness has not been maintained. Ignition of particles can be sufficient to ignite heavier metal sections, thus causing an accident.

The probability of a temperature rise increases with the differential pressure as is present when rapidly filling an almost empty oxygen cylinder from a full high pressure cylinder. The degree of temperature rise is directly proportional to the ratio of supply cylinder pressure to the residual pressure of the cylinder being filled. Spontaneous combustion of materials, combustible in oxygen, is less likely to occur at near atmospheric pressure conditions. It can be promoted, however, by external sources of heat.

7. TRANSFILLING SYSTEM MATERIAL

Materials used in the construction of all components of a piping system must be compatible with, and shall not combine chemically with, oxygen under the conditions of pressure and temperature which will be encountered. Many materials which are considered to be non-reactive at low pressures and normal temperatures may react with oxygen at high pressure and high temperature. For example, steel is a satisfactory material for high pressure oxygen cylinders at normal ambient temperatures. Steel is NOT recommended for oxygen piping system components at high pressure where heat may be generated by friction, compression, or external sources. For proper materials refer to AIR822, Oxygen Systems for General Aviation. However, small diameter, clean, heavy-wall copper or stainless steel tubing is considered safe by most authorities for pressures up to 20.68 MPa (3000 psig). Special attention must be given to the selection of valve seats, packings, hose linings, and gaskets, as many of these materials react chemically with high pressure oxygen. High pressure flexible hose, used in filling systems, shall, in addition to the requirements above, be free from objectionable odor.

7.1 General Guidelines

- Only components designed, built, and cleaned for oxygen service should be used.
- Only materials suited for the anticipated temperature condition should be selected for the system.
- All components should be suitable for the pressure to which they may be subjected.

8. STORAGE AND HANDLING

NOTE: Reference CGA pamphlet P-1 Safe Handling of Compressed Gas Cylinders for complete details.

8.1 Cylinders should not be subjected to extremes of heat and cold.

8.2 Cylinders should be protected from corrosive atmospheres.

8.3 Cylinders should be handled carefully so as to avoid dropping and to avoid physical abuse to the attachments.

8.4 Cylinders or equipment for handling oxygen should be stored in a clean area, free of grease, oil and other contaminants.

8.5 The valve outlet port on cylinder valves must be capped to prevent the entrance of contaminants when not in use.

8.6 Supply cylinders should be secured in place by appropriate constraints (in addition to the manifold plumbing).

8.7 During storage or transfer the cylinder valve must be capped or covered for protection from damage and contamination.

8.8 Containers

Compressed gases are commercially available in cylinders manufactured to DOT specifications. Such containers are filled, maintained, and shipped in accordance with appropriate DOT regulations. DOT cylinders are marked to indicate the specification number and the "service pressure" for which the cylinders are designed. This marking is normally located immediately below the neck ring, and consists of a combination of numbers and letters. For example, the designation DOT3A1800 indicates that the cylinder was fabricated and tested in accordance with DOT Specification 3A for a service pressure of 1800 psig (12.4 MPa). Additional marks, normally located beneath the above marking, include an identifying mark of the cylinder manufacturer and a serial number. In addition, the date of original manufacture and a symbol identifying the manufacturer are also located on the shoulder of the cylinder. For example, 9D65 indicates the cylinder was manufactured in September, 1965, by the Doe Company. DOT cylinders must be checked for a valid test date prior to each recharge. A DOT 3A or 3AA cylinder must be retested, prior to recharge, if its last test date is older than 5 years (or older than 10 years if the cylinder bears a metal-stamped star adjacent to its identity). A DOT 3HT cylinder must be retested, prior to recharge, if its last test date is older than 3 years. DOT 3HT cylinders must be removed from service after 24 years from the date of manufacture. DOT 3AA cylinders may remain in the special decennial retest program (indicated by a metal-stamped star) only for 35 years since the date of cylinder manufacture. Fully wrapped Composite cylinder are manufactured to Special Permits or Exemptions issued to the manufacturer of the cylinder. They typically have a metal liner over wrapped with a fiber and resin winding. The life limit on these cylinders is typically 15 years and they are required to be retested at a time interval specified by the the Special Permit (typically 5 years) or Exemption (typically 3 years).

9. GENERAL INFORMATION ON CONTAINER ON/OFF VALVES, PRESSURE RELIEF DEVICES AND REGULATORS

Oxygen valves in DOT specification cylinders are normally supplied with Compressed Gas Association standard outlets. Only oxygen regulators or other fittings having corresponding thread forms shall be attached to the valve. Proper connecting fittings can be obtained from a gas supplier. Such valves normally are equipped with a safety relief device or Pressure Relief Device (PRD) who's type and pressure settings are in accordance with DOT regulations required for the specific type of cylinder it is installed on. This device is normally located on the valve or cylnder mounted regulator and has the appearance of a hexagonal nut with several small holes in it. This device is exposed to the internal cylinder pressure at all times. Under no circumstances should any attempt be made to loosen or tighten this nut while the cylinder is pressurized. Valves and cylinder mounted regulators in special applications, such as in aircraft or military equipment, are frequently supplied with outlets which do not conform to the Compressed Gas Association standard. Only fittings which correspond to these outlets should be used. Such fittings can be obtained from the supplier of the equipment in which the special valve is used. Regulators are devices used for the control of pressure and flow rate when withdrawing gas from storage containers. They are designed and fabricated for use with specific gases and at specific maximum pressures. Only regulators for the gas and pressure to be controlled should be used. A regulator should never be changed from one gas service to another.

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, Transfilling of High Pressure Gaseous Oxygen Used for Respiration, (see reference section) and with local regulations. Only service technicians trained in the inherent hazards of high pressure aviation oxygen and knowedgable in this equipment may service this equipment.

NOTE: The material which has been presented herein is for information purposes, and is presented to call attention to some of the most important points to be considered when handling oxygen. No attempt has been made to specify the equipment to be used, as this is the joint responsibility of the consumer and the suppliers of gas and equipment. Additional valuable information is available in pamphlet form from the Compressed Gas Association.(See Section 2.0 References)

The suggested filling or "transfilling" procedure which follows sets forth the most important points to be observed in transferring oxygen from one container to another. It is believed that careful attention and adherence to this procedure will greatly reduce the frequency of occasional accidents associated with the transfer of oxygen.

10. SOURCE OF SUPPLY

10.1 The source of supply will normally consist of one or more cylinders containing oxygen gas under high pressure. They may be individual cylinders to be connected to the supply manifold as required, or they may be permanently mounted in a portable bank or cart.

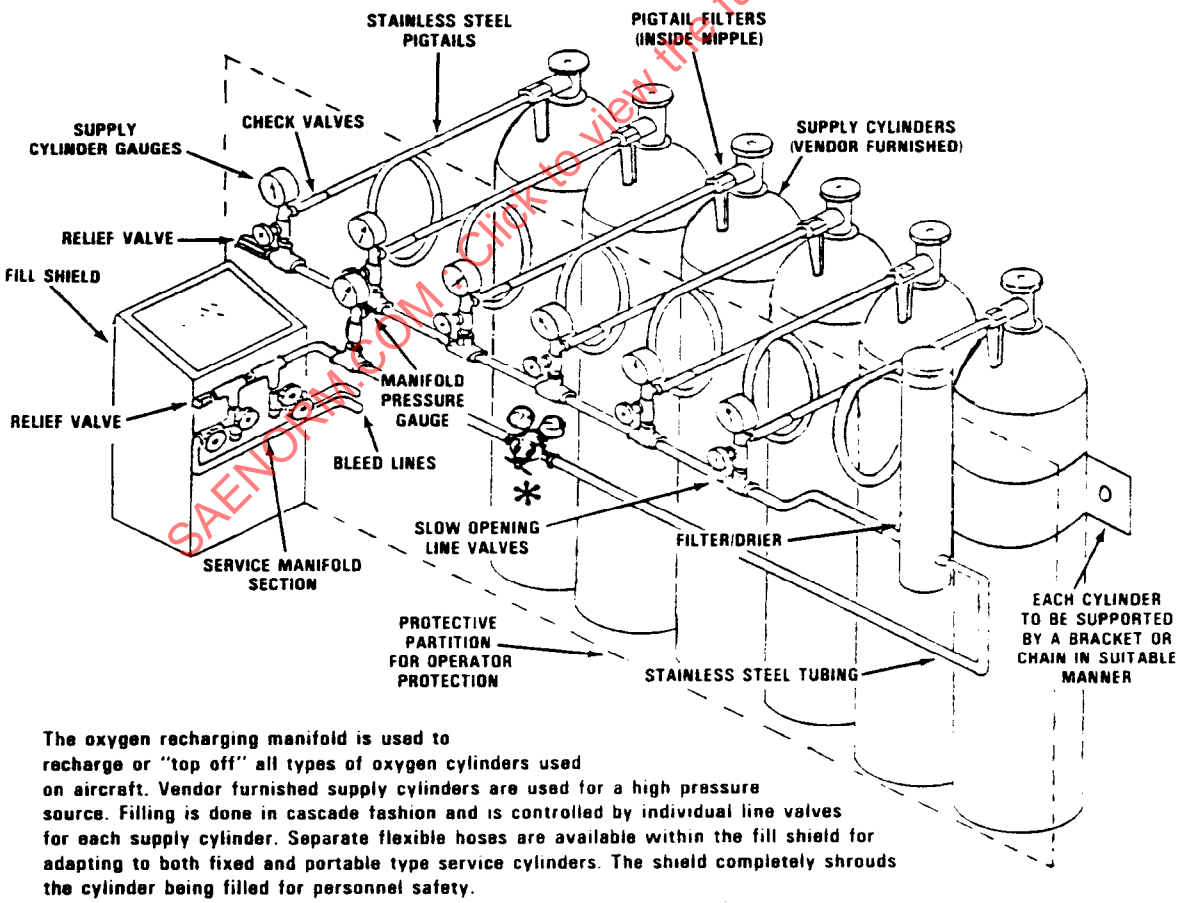
10.2 Only cylinders which are marked for the same pressure service should be attached to the supply manifold at the same time.

10.3 Only cylinders which have their contents clearly identified as “Aviators Breathing Oxygen” (either MIL-PRF-27210 or AS8010) should be used.

10.4 Supply cylinders should be equipped with valves having outlet connections conforming to Compressed Gas Association No. 540. (See Appendix A for other CGA Publications.)

10.5 Manifolds, gauges and piping used to interconnect supply cylinders being filled should have been manufactured and cleaned for oxygen service at the pressure to be contained. Such manifolds normally terminate at a control valve and pressure controlling device which can be connected to the filling hose and the container to be filled. Pressure gauges (with both metric and English pressure markings) should be provided which will make possible the reading of pressure on both sides of the control valve or device. These gauges should be certified as acceptable for oxygen service and should be checked each 6 months for condition and accuracy.

10.6 A typical manifold source of supply is illustrated in Figure 1.



The oxygen recharging manifold is used to recharge or "top off" all types of oxygen cylinders used on aircraft. Vendor furnished supply cylinders are used for a high pressure source. Filling is done in cascade fashion and is controlled by individual line valves for each supply cylinder. Separate flexible hoses are available within the fill shield for adapting to both fixed and portable type service cylinders. The shield completely shrouds the cylinder being filled for personnel safety.

* When the charging of low pressure cylinders (3.44M Pa. 500 PSIG) is anticipated, a pressure regulator should be installed in the high pressure outlet line just down stream of the filter/drier.

FIGURE 1 - MANIFOLD-OXYGEN RECHARGING (AIRCRAFT SERVICE CYLINDERS)

11. CONTAINERS TO BE FILLED

Cylinders offered for filling should be carefully examined, cleaned as required (see Section 4.9) and inspected to determine:

11.1 That they are identified for oxygen service by tag, label, decal, color code, etc.

11.2 That the valves are free of dirt, oil, grease, etc. and in fact are “oxygen clean.”

WARNING: Cylinders which are un-identified or which have contained gases other than oxygen, or which show evidence of dirt, grease, etc., in or about the valves should not be filled. Contaminated cylinders and valves should be disassembled, cleaned, and reassembled in a manner suitable for oxygen use by a DOT authorized facility. Attempts to use such a cylinder without suitable inspection and cleaning can result in serious injury and death.

11.3 That the cylinder and valves are free of defects such as dents, arc burns, excessive corrosion, or evidence of fire damage. The cylinder shall not be filled if there is any evidence of damage. If the cylinder requires an examination and retest by a DOT authorized test facility. Note: Composite cylinders have additional damage acceptance criteria as outlined in their individual DOT Special Permits.

11.4 That the Cylinders have been retested within the appropriate time (see Section 8.8).

Cylinders which show evidence of damage or have not been properly retested within the required time shall not be filled. The cylinder requires an examination and retest by a DOT authorized test facility.

11.5 The proper pressure to which the container may be safely filled (see Section 8.8).

Containers which are not properly marked to indicate the safe working pressure shall not be filled.

11.6 The presence of residual gas.

NOTE 1: If residual gas is present, it is desirable, when the quality or type of gas is unknown, to determine that it is oxygen before any attempt is made to evacuate the container. It is normally desirable to have some residual oxygen gas in the cylinder as this prevents the entrance of moisture and eliminates the need to apply a vacuum prior to refilling.

NOTE 2: All cylinders should be evacuated, purged and dried prior to refilling (see section 4.9) unless the residual gas is known to be Aviators’ Breathing oxygen.

12. GENERAL PRECAUTIONS ON USE OF SUPPLY MANIFOLD

12.1 Only cylinders found to be acceptable for oxygen service in accordance with Section 11 should be connected to the supply manifold for filling.

12.2 Filling hoses, lines, adapters, etc., must be clean and suitable for oxygen service and suitable at the pressure to be contained. Such devices should be marked “For High Pressure Oxygen Service.”

NOTE: When not in use, all such filling devices should be stored in a clean area, or otherwise protected against contamination by dirt, oil, grease, etc. All open ends shall always be capped or plugged.

12.3 Threaded ends or other attachment means shall match the fitting on the cylinder to be filled (see Section 7).

12.4 NOTE: Under no conditions should excessive force be used in attempting to make a connection.

12.5 The cylinders being filled should be properly supported in a manner that will not induce any stress on the filling hose, fittings, or supply system.