AEROSPACE INFORMATION REPORT

AIR825/12	REV. A

Issued 2002-03
Revised 2003-03
Reaffirmed 2013-12

Superseding AIR825/12

Oxygen System Integration and Performance Precautions

RATIONALE

AIR825/12A has been reaffirmed to comply with the SAE five-year review policy.

FOREWORD

This document is one of a set of related documents. These documents comprehensively address the "Introduction to Oxygen Equipment for Aircraft", and are referred to as slash (/) documents, rather than chapters. The documents may be obtained as a set or individually. As the field of oxygen systems for aircraft has evolved, it became cumbersome for one document to cover the full range of subject matter. The reader who is seeking overall familiarity with oxygen systems for aircraft should read all of these documents that combine to form a general reference to oxygen systems. The reader who is familiar with oxygen systems for aircraft may want to obtain only the slash documents that pertain to topics that are of specific interest.

The document set is written as an introductory level, suitable for anyone who would like to understand the basics of oxygen systems in aircraft, and specifically for the engineer who has just recently been assigned to aircraft oxygen systems. Many of these documents point the reader toward more detailed treatments located in other SAE documents.

TABLE OF CONTENTS

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AIR825/12A

TABLE OF CONTENTS (Continued)

1. SCOPE:

Oxygen system integration and performance precautions are in particularly dependent on applicable sections of airworthiness requirements per FAR/JAR 25. In this document information will be provided on common principles and good practices regarding design criteria, installation, manufacturing, safety aspects and system handling during maintenance and inspection.

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, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AIR825/13	Guide for Evaluating Combustion Hazards in Aircraft Oxygen Systems
AS861	Minimum General Standards for Oxygen Systems
AIR1059	Transfilling and Maintenance of Oxygen Cylinders
AIR1176	Oxygen System and Component Cleaning, Packaging
AIR1390	Convenient Location of Oxygen Masks for Both the Crew and Passengers of Aircraft
AIR1398	Testing of Oxygen Equipment
ARP1532	Oxygen System Installation and Fabrication
AS8010	Aviator's Breathing Oxygen Purity Standard

2.1.2 FAR Publications: Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591.

FAR/JAR 25	Airworthiness Requirements
FAR 23	

2.1.3 CGA Publications: Available from Compressed Gas Association, 4221 Walney Road, 5th Floor, Chantilly, VA 20151-2823.

CGA No. 540	CGA Pamphlet V – I, American National, Canadian and Compressed Gas Association Standard for Compressed Gas Cylinder Cylinder Valve Outlet Connection for Oxygen

2.1.4 U.S. Government Publications: Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

AFGS-87226A U.S. Air Force Guide Specification for Oxygen Systems, Aircraft, General Specification for

MIL-STD-464

2.1.5 RTCA Publications: Available from RTCA Inc., 1140 Connecticut Avenue, NW, Suite 1020, Washington, DC 20036.

RTCA/DO-160D Environmental Conditions and Test Procedures for Airborne Equipment

2.2 Definitions:

SYSTEM INTEGRATION AND PERFORMANCE PRECAUTIONS: Measures to be considered by system design, manufacturing, installation, handling, maintenance and inspection to ensure system performance is in compliancewith applicable airworthiness requirements.

3. DESIGN OBJECTIVES:

Oxygen systems shall comply with regulations, specifications and recommendations as applicable to a whole system or subsystems and components.

Performance to be provided shall meet particular airworthiness requirements of FAR/JAR 25.1439 - 1453.

Environmental conditions such as:

- Temperature
- Altitude/pressure
- Humidity
- Rain-condensation
- Mechanical vibration
- Shocks
- Constant acceleration
- Fungus
- Pollution
- Explosive environment
- Magnetic effect
- Hermeticity
- Hazardous elements
- Susceptibility to high, radiation and conduction frequencies
- Lightning strike protection
- Fire
- Sand and dust

3. (Continued):

shall to be taken into account to ensure safe system function under any foreseeable operational condition. Where necessary, redundancies shall be incorporated to satisfy the requirements of an emergency system. For immediate availability and use, a system should be equipped with its own control and indication devices.

Dependencies and interfaces to other aircraft systems should be minimized to avoid undesirable impacts on system function.

In designated engine burst areas practical design measures should be taken to minimize, on the basis of good engineering judgment, the risk of system damage due to non-contained engine rotor debris.

4. GENERAL INSTALLATION PRINCIPLES:

4.1 Location of Dispensing Equipment:

Oxygen dispensing equipment shall be located within easy reach of the users according to recommendations of AIR1390 and FAR/JAR 25.1447.

4.2 Number and Type of Fittings - Locations:

The number of fittings should be kept to a minimum. Their location should allow easy inspection. Enough space must be provided to torque the fittings tight.

On tubings of a gaseous system only one connection type shall be used. Combination between flared and flareless fitting ends within a specifically defined system must be avoided.

The oxygen system must be leak tested after final installation.

All fittings must be located such that any escaping oxygen will not lead to appreciable accumulation of oxygen inside electronic racks or compartments. The fittings of the oxygen system should not be installed directly adjacent to fittings of fuel, oil or hydraulic systems.

4.3 Support for Oxygen Lines:

4.3.1 Rigid Tubes: Oxygen lines must be supported by clamps that prevent excessive line movement during aircraft flight and shall have adequate protection against chafing. Vibration isolator clamps are recommended where vibration is considered excessive to prevent lines from cracking or fracturing. Isolators minimize fatigue or fracture to oxygen lines from forces of flight. Ensure adequate space is provided to prevent lines touching aircraft structure or components. Supporting of oxygen lines on aircraft parts that are dislocated during maintenance actions shall be avoided.

4.3.2 Flexible Hose: Careful installation is most important to obtain long life from a flexible hose. Therefore, the location of supports shall ensure that:

- On the bends of the flexible hose no clamps will be used, preventing the movement of the flexible hose during tube elongation.
- No reciprocal contact between flexible hoses should occur.
- An uncontrolled oscillation of the flexible hoses can not occur.
- Motion always takes place in one plane.
- Care should be taken not to twist the hose while tightening.

4.4 Proximity to Combustibles:

Oxygen lines and supply components shall not be mounted below other lines or tanks that contain combustible fluids that could leak onto the oxygen tubing. In particular, no fuel, oil or hydraulic fitting shall be above or adjacent to any oxygen tube fitting(s) or component.

Accordingly parts of an oxygen system should be above and at least 150 mm (6 in) away from fuel, oil and hydraulic systems or areas where leakage of combustibles can collect. If, for design reasons, it is not possible to maintain the above mentioned minimum clearance, then the oxygen line shall be covered by a protective sleeve. Deflector plates should also be used to keep liquids (including high pressure spray) away from oxygen lines, fittings and equipment.

4.5 Proximity to Moving Aircraft Parts:

There should be at least a 50 mm (2 in) clearance at maximum point of movement or deflection between oxygen plumbing and equipment components and any moving aircraft parts. If this minimum clearance is not achievable, the oxygen line must be shielded against mechanical damage by assuming the worst load factors for the shield.

Particular attention should be paid to clearance to primary flight and engine controls where the distance should not be less than 12 in.

4.6 Proximity of Plumbing to Electrical Wiring:

When possible a 150 mm (6 in) clearance should exist. When this is not possible or practical a 50 mm (2 in) minimum is acceptable provided that the electrical wiring or wire bundles are rigidly supported by conduit and/or closely spaced clamps or clips. When less than 50 mm (2 in) separation is necessary wires or wire bundles and electrical components must have additional insulation and be so supported that they cannot deflect closer than 13 mm (1/2 in) from the oxygen components. As an additional protection the appropriate area of the oxygen line may be isolated by a retractable hose guard of non-corrosive material.

Further, oxygen tubes and tube fittings shall not be closer than 50 mm (2 in) without insulation to any electrical components such as relays that may be a fire source. Consider that if a fire did begin at the electrical component it may burn through the oxygen tube or fitting and the fire could be intensified by the addition of oxygen pressure and burning metal. A minor fire could become catastrophic.

4.7 Design Precautions:

Reducing valve(s) should be installed as close as practicable to high pressure oxygen cylinder to minimize the amount of high pressure line installation.

Oxygen cylinder(s) and lines shall be protected against high temperatures and shall not be installed in designated fire zones. The support(s) of the oxygen cylinder shall be designed to withstand the flight, landing and crash loads.

The installation of the oxygen cylinder, equipment and tubing shall be such that deformation of the fuselage in case of a landing with retracted nose landing gear or cargo shifting during crash landing will not cause rupture and escape of oxygen.

Flexible connections specifically designed for oxygen system shall be provided between all points having relative or differential motion.

4.8 Use of Dissimilar Materials:

The use of dissimilar materials must be avoided to prevent corrosion due to electric potentials. If this cannot be avoided the surfaces must be protected appropriately. Application of varnish or paint inside of oxygen equipment and lines shall be excluded.

4.9 Conduction of Electric Current:

All elements must be designed for the same current. This must especially be verified at the fittings.

4.10 Reverse Electric Currents:

Reverse currents on oxygen plumbing and equipment shall not occur.

The system must be checked for absence of reverse currents with all adjacent systems switched on.

4.11 Electrical Bonding:

All conductive components of the system must be protected against the effects of grounded electrostatic charge. The electrical resistance between the discharge mounting bases and the aircraft structure shall be for:

- Stainless Steel Components: 100 mΩ
- Aluminum Alloy: 10 mΩ

Electrical and non-electrical components shall be individually bonded to the structure either directly or through the pipe system using bonding leads. The use of vibration isolators may mean that bonding leads are needed at various mounting locations.

The system shall be bonded to the aircraft structure either through its attachments or by separate bonding leads.

4.12 Tubing Markings:

All plumbing (hose and tube assembly) shall have markings indicating "Breathing Oxygen," flow direction, and function such as "VENT," "FILL," "SUPPLY," etc.

4.13 Tubing Elongation:

Tubing elongation caused by thermal impact and/or fuselage movement shall be compensated by tubing arrangement, flexible clamps or flexible hose.

5. MANUFACTURING STANDARDS:

Requirements of AS861 shall be applied as far as necessary to define details for the design, fabrication, testing and packaging of oxygen breathing equipment. Refer also to ARP1532.

6. SAFETY REQUIREMENTS:

It is important to instruct the personnel charged with manufacture, installation, maintenance or control actions on oxygen system components about the danger, which such systems represent and the precautions to be taken.

Oxygen itself will not burn, but it is the element which supports combustion. An increase in oxygen concentration (or partial pressure) in the air accelerates combustion. Under certain circumstances (e.g., presence of hydrocarbon vapors, grease, etc.) self-combustion or even explosions can occur due to air enriched with oxygen.

Also particles transported by high speed sonic oxygen flow through tubing or valves can impact with sufficient force that they reach their autoignition temperature, followed by a perforation of the wall and a possible step by step fire propagation to other oxygen equipment or structure.

For these reasons it is essential to observe the following precautions:

Fabrication, packing, testing, installation, inspection, servicing, maintenance and repair of oxygen system components shall be done only by trained and qualified personnel using approved procedures.

Ensure that proper cleaning of components has been followed prior to installation.

All components should be capped and/or bagged and marked as suitable cleaned for oxygen service prior to any aircraft installation of oxygen equipment.

All tubing and system components shall be bonded if necessary in accordance with MIL-STD-464.

It shall be avoided to use routings where the flow direction will sharply turn around.

Use of asbestos is forbidden.

6. (Continued):

Cadmium plating shall not be used in contact with oxygen.

Use of titanium is prohibited in any component surface in contact with oxygen.

The working area must be isolated from oil, grease, paper, lint particles and other contaminants. It should be sufficiently ventilated and lighted.

The specific countries safety regulations for workers, laid down for oxygen, must be observed.

Particular guidance for safe designs, operations and maintenance on aircraft oxygen systems is provided in AIR825/13.

7. HANDLING INSTRUCTIONS:

7.1 General Equipment Handling:

All oxygen equipment should be handled with care. Most oxygen components are of an intricate nature and all require cleanliness for proper operation, therefore, they should be kept in their original containers or be provided with a proper protective covering until ready for installation in the aircraft. This is also necessary when any of the items from an aircraft are removed for service or overhaul. It is recommended that all products be obtained from properly qualified equipment manufacturers or representatives and that service and overhaul operations on such equipment be performed only by the original manufacturer or an agency authorized by the original manufacturer.

7.2 Pre-Installation Cleaning:

All components such as pressure regulators, reducer valves, check valves, in-line valves, indicators, and masks designated for oxygen use and obtained from properly qualified manufacturers and repair stations, should be produced or serviced with special care to ensure cleanliness and components free of any contamination. Therefore, no cleaning is required prior to installation; however, the person making the installation should have clean hands, clothing, and tools and should use care so as to prevent introducing contamination.

7.2 (Continued):

Plumbing lines, connections and fittings designated for use in oxygen service or removed with the intention of re-installation in oxygen systems should be cleaned in accordance with the following suggested practices:

- Conduct cleaning operations only in an area where there is no close association with contaminations such as grease, lubricants, asphalt, or any other combustible.
- Each line or fitting should be flushed with suitable solvent or appropriate aqueous cleaner. Any solvent must be fresh, not having been used for any other purpose, and should be periodically examined for contamination if the solvent is continually used for oxygen equipment cleaning.
- Care should be taken to ensure that the interior of the tubing and fittings are thoroughly cleaned and dry and that handling does not introduce additional contamination.
- Visual inspection should be conducted to ascertain that lines and fittings are completely free of contamination.

Immediately, cleaned lines and fittings should be covered with clean protective bags, plugs, and caps. Plugs or caps used shall be of dry and clean metal or a clean non-shredding PVC, it should be ensured that these parts will be used on oxygen systems only. Ends of lines or fittings should not be taped because a residue is left when tape is removed. Lines or fittings should not be placed or stored anywhere near machinery or other equipment where they might become contaminated from oils, greases, dust or water. Protective covers such as packaging and plugs should not be removed until the line is finally installed, and mechanics must be careful that hands and tools do not contaminate the system during installation.

7.3 Oxygen Masks:

Masks may be cleaned by being thoroughly washed with cleaning solvents recommended by manufacturers in the manuals. Care must be exercised to ascertain that the valving, both inhalation and exhalation, is properly cleaned and not damaged during the cleaning process. The masks should be tested by a qualified manufacturer or repair station to manufacturer's overhaul manual requirements to determine that the valving mechanisms are not sticky and that they function properly after the cleaning process. Cleaning may necessitate the disassembly of the valves and each valve's parts being cleaned separately. Manufacturers or approved repair stations should have proper equipment to test the opening pressures and sealing characteristics of the inhalation and exhalation valves. Many oxygen masks in general aviation use are of the inexpensive, disposable type. These are not designed to be serviced but are discarded after being used or when they are damaged or contaminated.

7.4 Oxygen Cylinders:

The cylinders used in general aviation are high pressure type cylinders (1800 to 2000 psi) and they must be handled with extreme care because of these high pressures.

Requirements for inspection differ with each type of cylinder. Oxygen cylinders when handled should be protected from abuse, scratches, denting, high temperature and high pressure condition; cylinder valves, in particular, should be protected with all ports covered as recommended before. Care should be taken to avoid the reduction of oxygen cylinder pressure below 50 psi before recharging, as this will help prevent contamination of the cylinder from moisture. Protective thread covers should not be removed until the cylinder is installed in the airplane.

8. MAINTENANCE AND INSPECTION METHODS:

8.1 Oxygen System Maintenance:

As previously noted, all components should be retained in original packaging with proper protective plugs until immediately prior to use or installation in the aircraft. No lubricants, except those which are approved for oxygen use, should be used in making connections or in lubricating threaded connections.

Care must be taken to keep excessive lubrication from being used as it oozes into the internal parts of the tubing and components and is internal in areas that see oxygen service. This has been a common problem on past aircraft oxygen equipment maintenance and has caused fires and destruction of aircraft.

Care should be taken to protect all lines and fittings from any unnecessary abuse or scratches during installation. Low pressure aluminum alloy plumbing lines are likely to become damaged; therefore, installation and location should be so accomplished as to prevent oxygen equipment or plumbing from subjection to vibration, abrasion, or damage during other maintenance operations. Temporary protection devices may be needed to prevent stepping on or damage from equipment movement during maintenance.

All oxygen systems lines, after installation, should be carefully inspected for damage and leakage. Leak testing can be accomplished by introducing the oxygen pressure into the system and examining connections by the use of a leak detector solution specifically approved for oxygen service. Before any oxygen system component is removed or any connection is loosened, oxygen system pressure should first be dissipated, after first shutting off the cylinder valve.