



**Civil Aviation  
Advisory Publication  
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# Design and Fitting of Oxygen Systems: non required gaseous oxygen equipment

***This publication is only advisory, but it gives the CASA preferred method for complying with the Civil Aviation Regulations 1988 (CAR 1988).***

***It is not the only method, but experience has shown that if you follow this method you will comply with the CAR 1988.***

***Always read this advice in conjunction with the appropriate regulations.***

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## The relevant regulations and other references

- Regulation 35 of CAR 1988 (CAR 35)
- Civil Aviation Order (CAO) 108.26 - System Specification - Oxygen Systems
- Code of Federal Regulations 14 Aeronautics and Space, Parts 23, 25, 27 and 29 (FAR)
- Federal Aviation Administration (FAA) Advisory Circular (AC) 27-1B Certification of normal category rotorcraft
- FAA AC 43.13 - 2A Acceptable methods, techniques and practices - Aircraft alterations
- AS 1777 - 1995 Aluminium cylinders for compressed gases - seamless - 0.1 kg to 130 kg
- AS 2030.1 - 1999 The verification, filling, inspection, testing and maintenance of cylinders for storage and transport of compressed gases
- AS 2896 - 1998 Medical gas systems - Installation and testing of non-flammable medical gas pipeline systems
- AS 2902 - 1986 Medical gas systems - Low pressure flexible connecting assemblies (hose assemblies)
- AS/NZS 3840.1 - 1998 Pressure regulators for use with medical gas - Pressure regulators and pressure regulators with flow-metering devices
- SAE AIR 1392 Oxygen system maintenance guide
- SAE ARP 1532 Aircraft oxygen system design, fabrication, test and installation
- SAE ARP 4761 Guidelines and methods for conducting the safety assessment on civil airborne systems and equipment.

*Note: State laws may require compliance with Australian Standards. These laws may be administered by organisations other than CASA.*

## **Who this CAAP applies to**

Persons holding an Instrument of Appointment under CAR 35 for the purposes of approval of gaseous oxygen system installations, other than for supplemental use, to be installed in an Australian registered aircraft.

Certificate of registration holders of aircraft having non-required gaseous oxygen systems fitted or carried in their aircraft.

## **Why this CAAP was written**

This CAAP provides guidance on a range of matters that need to be considered to ensure that non-required gaseous oxygen systems fitted to an aircraft will not be a potential threat to the safety of the aircraft while either on the ground or in flight.

## **Status of this CAAP**

This is the first issue of CAAP 35-5. The CAAP will remain current until it is either cancelled or suspended.

## **For further information**

Contact the CASA Office closest to you.

## 1. Introduction

1.1 CAO 108.26 details the specifications and requirements for supplemental oxygen and protective breathing equipment that must be met on Australian registered aircraft. FAA AC 27-1B gives guidance on the design and construction of gaseous oxygen systems that are to be fitted to helicopters, other than for supplemental oxygen use and SAE 1532 gives further information on the fabrication, test and design of such systems. This CAAP provides additional information for the design and fitment of non-required oxygen systems to aircraft.

*Note: Oxygen is neither explosive nor flammable. However, under certain circumstances oxygen can support combustion of materials that might otherwise be considered non-flammable. Extreme care must be taken with cleanliness of the system and, in particular, oils or greases are not to be used.*

1.2 Approval of the design of modifications that provide a convenience, or function that is not part of the applicable airworthiness standards, is normally not required. However, because of the potential hazards, gaseous oxygen system installations must be approved under CAR 35 after an evaluation to ensure that no hazard or interference is caused to the aircraft.

1.3 The approval under CAR 35 must address the original or later certification basis of the aircraft, and the design must comply with any relevant design standards.

*Note: The design of oxygen systems is a specialised function. The CAR 35 authorised person approving the installation should be conversant with the problems and dangers associated with design and use of gaseous oxygen systems.*

## 2. Earthing and bonding

2.1 All metallic components of the oxygen system should be protected against catastrophic effects from lightning and static electricity. This can be achieved by securely bonding all the components to the airframe.

## 3. Cylinders

3.1 Non-aviation oxygen cylinders may be used for this type of installation provided that aluminium cylinders used meet AS 1777 - 1995 design standards. Also all cylinders must be tested to AS 2030.1 - 1999 which requires that cylinders be hydrostatically tested

every 10 years and the test date be clearly marked on the cylinder. Cylinders that have exceeded the prescribed test period are not to be used.

3.2 While a thermal relief valve is desirable in this type of installation, this may not be possible due to difficulty in obtaining cylinders with this fitted.

3.3 Cylinders located where they may be damaged by baggage or stored materials should be protected by guards or covers.

3.4 Emergency landing conditions need to be considered in mounting the cylinders. The inertia loads are to meet the requirements of the certification basis of the aircraft.

*Note: An oxygen cylinder should not be charged beyond the maximum rated pressure of the cylinder.*

#### 4. Oxygen lines

4.1 **General.** Lines that pass through potential fire zones should be copper or alloys such as Monel for high and low pressure and may include stainless steel for low pressure. All lines are to be cleaned prior to installation in accordance with FAA AC 43.13-2A Chapter 6. Care should be taken to ensure that all surfaces coming into contact with oxygen are free of oils, grease and particulate contaminants such as talc or dust.

4.2 **High Pressure.** Oxygen lines from the cylinders to the regulator, if remote from the cylinder, are subject to high pressure and must be designed to withstand full cylinder pressure. High pressure lines should be made from copper or alloys such as Monel and should be no more than 46 cm (18 inches) in length. The maximum length of the pipe is to ensure that high pressure runs are kept as close as possible to the source. The lines should be formed to reduce repeated plastic deformation such as when replacing oxygen cylinders. Line diameters should be limited to a size that is adequate to carry the flow at the minimum cylinder operating pressure. This can usually be achieved by using an internal diameter of 1.6mm ( $1/16$  inch). All pipes should be pressure tested to twice the system operating pressure on a test bench prior to installation in an aircraft. After testing the pipes should then be thoroughly cleaned to remove all traces of oil or grease.

*Note: Flexible hoses or pipes should not to be used in any part of the high pressure system.*

**4.3 Low Pressure.** Low pressure lines hidden from view during normal operation should be solid metal lines or high pressure flexible lines that are approved by the manufacturer for oxygen use and should meet AS 2902 - 1986. Low pressure flexible hoses should only be used where the line is visible at all times during normal operation and not exposed to continuous pressure. All pipes should be pressure tested either on a test bench or in-situ using dry air or nitrogen to at least twice the system operating pressure with nil leakage over a one hour period. Care must be taken to account for the fittings within the low pressure system which may be affected by high pressure in case of a system failure where high pressure oxygen escapes into the low pressure system. An example is the failure of the regulator. Protection against high pressure in the low pressure pipes can be provided by a line pressure safety valve (refer to the Shut-off Valves section).

**4.4** Hoses may be used with nipples where the end fitting is a purely cylindrical type and is swaged over the hose and nipple using a press.

## **5. Filters**

**5.1** Consideration should be given to use of sintered filters to all entry points to regulators and high pressure valves, other than the cylinder valve. These filters will prevent entry of particles into the system and reduce the likelihood of a particle causing adiabatic heating or rupture of a hose.

## **6. Fittings**

**6.1 General.** All fittings used in oxygen systems must be manufactured from materials that are compatible for use with oxygen such as copper, Monel and Inconel in accordance with AS 2896 - 1998. Fittings should not be made of mild steel or materials that are prone to corrosion when in contact with another material. All fittings should be cleaned prior to installation in accordance with AS 2896 - 1998 or FAA AC 43.13-2A Chapter 6.

**6.2 High Pressure.** Inter-cylinder connections should be made with regular flared or flareless tube fittings. Fittings that are of the same material as the lines are recommended. Testing and cleanliness should be as for high pressure lines.

6.3 **Low Pressure.** Fittings for metallic low pressure lines may be regular flared or flareless, similar to high pressure lines. Universal fittings or friction nipples in conjunction with hose clamps should not be used in pressurised oxygen systems.

6.4 **Outlets.** All outlets should be of an automatic shutoff type, with a flow limiting restrictor in the socket or plug fitting.

## 7. Thread compound

7.1 If anti-seize or thread compound is used, the product should conform to MIL-T-5542-B specification or equivalent that is clearly labelled as compatible for use with oxygen systems.

7.2 Thread compound should not be used on aluminium alloy flared fittings having straight threads. Proper flaring of this type of fitting should be sufficient to prevent leaking.

7.3 All male tapered pipe threads should be treated with anti-seize and sealing compound or tetrafluoroethylene tape (MIL-T-27730), or equivalent. The compound should be used in accordance with the manufacturer's recommendations. Apply compound sparingly to the first three male threads from the end of the fitting. Compound should not be used on coupling sleeves or on the outside of the tube flares.

## 8. Shut-off valves

8.1 A slow opening shutoff valve must be attached to each cylinder in accordance with AS 2896 - 1991. For emergency medical systems this should be accessible to a crew member at all times during normal operation. If the mounting of the cylinders is such that the shut-off valves are inaccessible to the aircraft crew or medical team members, an excess flow check valve followed by a line pressure safety valve is an acceptable alternative. This valve should be set to lift at 30% above nominal working pressure to protect the regulators and lines against high pressure in the event of a partial failure of the regulator. These should be installed as close as possible to the cylinder and vented overboard. Design of flow valve settings should be supported by tests demonstrating that the maximum flow will not result in nuisance trips and reliable trips will occur during a malfunction condition.

## 9. Regulators

9.1 The regulator should be suitable for use with oxygen and should be mounted as close as possible to the cylinder. If non-aviation regulators are used, careful consideration should be given to any manufacturer's environmental qualifications, and particular attention should be given to the manufacturer's vibration, altitude and temperature tolerances of the regulator. Non-aviation regulators should meet Australian Standard AS/NZS 3840.1 - 1998 or similar standard.

*Note: Regulators that are not manufactured to an approved standard should be carefully assessed for their operational reliability and suitability.*

9.2 Regulators which have in-built relief valves should have the relief port vented overboard using suitable metal pipe.

## 10. Placards

10.1 Appropriate and durable placards should be provided with any installed system warning of the dangers associated with the use of oxygen. Emphasis should include any precautions such as no smoking and use no oils or greases etc.

10.2 The following information should be placarded adjacent to the oxygen cylinders or filler connection:

**MEDICAL OXYGEN SYSTEM  
NO SMOKING  
TURN OXYGEN ON SLOWLY  
CAP OFF OXYGEN LINES WHEN NOT IN USE  
KEEP THIS AREA FREE OF OILS, GREASE, DIRT  
AND HYDROCARBONS**

10.3 If the system has removable oxygen cylinders the following should be added:

**OXYGEN CYLINDERS ARE NOT TO BE FILLED  
IN-SITU  
INSTALLERS ARE TO TAKE CARE WHEN  
INSTALLING OXYGEN CYLINDERS SO THAT  
SURROUNDING EQUIPMENT AND AIRCRAFT  
ARE NOT DAMAGED**

10.4 Any oxygen outlet and valves located in the cabin should have at least the following placards adjacent to the fittings:

<p><b>OXYGEN</b> <b>NO SMOKING</b></p>
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## 11. Filler connection

11.1 A filler connection, if provided, should:

- be located outside the fuselage skin or protected by an access door on the fuselage;
- be of the slow acting type;
- have a large vented area around the filling nipple;
- be mounted in a manner that would minimise leaking oxygen from entering the aircraft; and
- be placarded.

11.2 Any mounting point should also take into consideration the location of fuel, oil and hydraulic sources.

## 12. Oxygen masks

12.1 Aviation-style masks may not be suited to medical use. Medical approved oxygen rated masks are acceptable for this application. Face masks or cannulas should be of a type suitable for the intended purpose.

## 13. Continuing airworthiness

13.1 All medical oxygen system equipment including regulators, oxygen outlets and valves should be maintained in accordance with manufacturer's instructions and by personnel qualified to maintain oxygen equipment. (If the manufacturer of the oxygen equipment does not have specific maintenance requirements, the maintenance requirements should be established by qualified oxygen maintenance personnel and a suitably experienced CAR 35 authorised person as part of the continuing airworthiness program).

13.2 Oxygen cylinders and valves must be hydrostatically tested every ten years in accordance with AS 2030.1 - 1999. Any repair or maintenance on the installed system should be performed by maintenance personnel and recorded in the aircraft documentation, including the recharging or replacement of the oxygen cylinders. SAE AIR 1392 Oxygen System Maintenance Guide details acceptable methods of system maintenance.

*Note: Cylinders and other components once removed from the aircraft may have minor routine maintenance performed by suitably qualified medical staff.*

13.3 A maintenance schedule should also be developed and include periodic maintenance requirements, cleaning and precautions on the use of oxygen.

## **14. Documentation**

14.1 A flight manual supplement should be included for any system permanently fitted to an aircraft. This supplement should detail any precautions necessary for the safe use and operation of the oxygen system, including all precautions and warnings associated with the use of oxygen.

*Note: Warnings to flight crew and operators should include advice that high pressure lines should be pressurised prior to loading portable equipment onto an aircraft.*

14.2 Procedures should take into consideration State laws on the refilling of oxygen cylinders. This should include on who may fill cylinders and where they may be filled.

## **15. Certification**

15.1 The design and construction of an oxygen system permanently fitted to an aircraft constitutes a modification to the aircraft. A CAR 35 authorised person must approve all aspects of the design of the system. This includes the mounting brackets and all components used with the oxygen system. The equipment and systems must be installed to ensure adequate performance and functions under any foreseeable operating conditions. The design must maintain and continue to meet the certification basis of the aircraft. A Functional Hazard Assessment, performed in accordance with SAE ARP 4761, is usually required to show continued compliance with the design standard and that there is no hazard or interference to the safe operation of the aircraft.

15.2 Oxygen installations are potentially hazardous and complex and consideration should be given to applying for a Supplemental Type Certificate for the design and installation of non-required gaseous oxygen equipment.

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