

Specification for

General design requirements for aircraft oxygen systems and equipment

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Committees responsible for this British Standard

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- British Compressed Gases Association
- Civil Aviation Authority (Airworthiness Division)
- Ministry of Defence
- Society of British Aerospace Companies Limited

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Foreword

This British Standard has been prepared under the direction of the Aerospace Standards Committee and is a revision of BS 2N 100 which is withdrawn. The following factors were taken into account in the preparation of this revision:

- a) the oxygen requirements for maintaining physiological efficiency in flight (see Appendix C);
- b) the fire and explosion hazards associated with oxygen (see Appendix D);
- c) the requirements for oxygen, nitrogen and air for testing oxygen equipment (see Appendix B);
- d) the compatibility of the materials in the presence of oxygen (see Appendix A);
- e) the selection of materials suitable for use in oxygen systems (see Appendix E);
- f) the design and installation of oxygen systems (see Appendix F);
- g) absolute pressure ranges from zero to 34.6 MPa.

Following the 1987 Asbestos Audit report the committee considered the requirement to use asbestos packing material for the thermometer in Figure 4 and concluded that asbestos should not be used. AMD 6197 has been issued to permit the use of any packing material which is inert to an oxygen enriched atmosphere.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 18, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This British Standard specifies the general design requirements for airborne oxygen breathing systems, including oxygen storage and generation equipment. Tests are described for compatibility of materials for use in the presence of oxygen.

In addition, for all equipment for aircraft oxygen systems, compliance with the relevant Parts, Sections and Subsections of BS 3G 100 is specified.

NOTE 1 The titles of the publications referred to in this standard are listed on the inside back cover.

NOTE 2 The latest revision of an Aerospace Series standard is indicated by a prefix number.

2 Pressure ranges

The absolute pressure ranges used in this standard shall be defined as follows:

- a) low pressure: zero to 0.4 MPa;
- b) medium pressure: 0.4 MPa to 1.5 MPa;
- c) high pressure: 1.5 MPa to 20.8 MPa;
- d) very high pressure: 20.8 MPa to 34.6 MPa.

3 General requirements

3.1 Fixed systems shall be installed so that components and pipelines are:

- a) separated from other potentially hazardous systems, for example electrical, hydraulic and fuel systems;
 - b) located so that accumulation of oxygen will not cause a hazard;
- NOTE Attention is drawn to the guidance given in F.8.2.
- c) clear of moving controls and other mechanisms;
 - d) bonded to earth in accordance with current military and civilian aircraft requirements.

In addition, fixed systems shall also be installed so that components and pipelines are

- 1) routed to minimize the number of joints, the lengths of supply pipes and the number of sharp bends;
- 2) protected against the ingress of grease and other contaminants;
- 3) supported and protected against adverse effects of vibration and acceleration.

3.2 Parts of the system subject to high or very high oxygen pressures, located in crew and passenger compartments, shall be either routed or physically protected to prevent accidental damage.

NOTE Attention is drawn to the guidance given in F.8.1.

3.3 There shall be no sharp edges, burrs or thin sections within the oxygen stream.

NOTE In high velocity oxygen flow conditions, sharp edges, etc. may result in ignition through unacceptably high temperatures being generated.

3.4 Items installed on or adjacent to a user shall have no sharp corners, edges or protrusions that can cause personal injury or catch on clothing or equipment.

3.5 Where oxygen is supplied from chemical generators, the effect of heat emission from the generator on the installation and adjacent equipment shall be taken into account for normal and inadvertent operation.

3.6 Individual components shall be compatible with the rest of the system.

NOTE Compatibility of components should be ensured during their design, development and qualification test. System design should include consideration of the following.

- a) Container size, storage pressure, system flow characteristics, the need for a reducing valve and the regulator inlet working pressure range. All these factors are interlinked and have to be considered together to produce the optimum overall storage and supply system.
- b) The pressure/flow dynamics of the system, especially with regard to the stability of inspiratory flows. The regulator, low-pressure delivery pipelines, mask and the human respiratory system are usually the critical, interacting items.
- c) The acoustic characteristics, that is the "breathing noise" produced in any system which includes a mask-mounted microphone. Here the regulator, low-pressure pipelines and mask are usually the critical, interacting items.
- d) The integration of certain components such as the regulator and associated pipelines, with the seat, the clothing and any personal equipment.
- e) Condition of handling, storage and use, so that equipment performance is not adversely affected.
- f) Safety, reliability and maintainability.

3.7 The system shall include emergency oxygen equipment for passengers and crew.

NOTE It is essential that emergency oxygen equipment be immediately available and in a serviceable condition at all times.

3.8 Where blind or intuitive operation of a handwheel or rotary lever is required, the sense of operation shall be such that an upwards or forwards movement of a lever opens or increases the supply. Shut-off valves shall be opened by an anti-clockwise movement of the handwheel or rotary lever and closed by a clockwise movement.

3.9 High and very high pressure shut-off valves shall be designed that when operated the rate of pressure rise within the system does not result in the development of a dangerously high temperature.

4 Materials

4.1 Material compatibility in presence of oxygen

4.1.1 *General.* Metallic and non-metallic materials to be used in liquid oxygen, gaseous oxygen or oxygen rich atmospheres shall pass the requisite number of the following tests and, for a working pressure greater than 20.8 MPa shall pass both the “bomb” and impact tests, described in Appendix A, for ignition behaviour in the presence of oxygen:

- a) the “bomb” test;
- b) the “pot” test;
- c) the impact test.

NOTE Guidance on selection of materials is given in Appendix E.

4.1.2 *Protective treatment.* Where protective treatment is applied to parts of the system, it shall not affect the ability of the material to comply with 4.1.3 to 4.1.5.

4.1.3 *Compatibility with oxygen in respect of fire hazards (bomb test).* When tested in accordance with A.3.2, material having a spontaneous ignition temperature (SIT) value in accordance with Table 1 shall be deemed to be compatible for use with oxygen in respect of fire hazards, at the declared working pressure and maximum working temperature of 90 °C.

Table 1 — Minimum bomb SIT at 13.2 MPa test pressure

Maximum working pressure	Minimum SIT
MPa absolute	°C
0.4	200
1.1	230
2.1	250
4.1	300
10.1	350
15.1	375
20.8	400
Above 20.8 up to 34.6	400
NOTE 1 Both bomb SIT and impact tests are required for working pressures greater than 20.8 MPa.	
NOTE 2 For working pressures less than 0.4 MPa only the “pot” test need be satisfied.	

4.1.4 *Compatibility with low pressure oxygen systems (pot test).* When tested in accordance with A.3.3, material shall be deemed to be compatible for use with low pressure oxygen systems if the highest temperature recorded on six consecutive tests is not less than 250 °C.

4.1.5 *Compatibility with liquid or gaseous oxygen (impact test).* When tested in accordance with A.3.4, material shall be deemed to be compatible for use with liquid oxygen or gaseous oxygen if no audible detonation and not more than one visible ignition occurs.

4.2 Metallic materials

Adjacent metals shall be electrolytically compatible.

NOTE At low temperatures the dimensions and properties of many metals are changed. Due account of this should be taken, particularly when designing stressed components.

4.3 Non-metallic materials

4.3.1 Non-metallic materials shall be odourless and non-toxic.

4.3.2 Dyes and pigments used for colouring shall be fast in the presence of human perspiration.

4.3.3 Non-metallic materials, when worn in contact with the skin, shall be non-dermatitic.

4.3.4 All finishes shall be non-flaking.

4.3.5 Only lubricants, anti-siezing, sealing and locking agents, which do not affect the ability of non-metallic materials to comply with 4.1.3 to 4.1.5 shall be used.

4.3.6 Non-metallic materials shall not support fungus or mould growth when tested in accordance with BS 3G 100-2.3.3.

NOTE At low temperatures the dimensions and properties of many non-metallic materials are changed. Due account of this should be taken, particularly when designing stressed components.

5 Pressure joints

Equipment shall be gas-tight when tested in accordance with Appendix B and when subjected to the environmental conditions given in BS 3G 100-2.3.2 for the relevant grade.

6 Couplings and connections

6.1 Replenishment couplings

6.1.1 In-situ replenishment facilities shall be provided with means to prevent excessive rates of charging resulting in dangerously high temperatures within the system.

NOTE 1 In gaseous systems, to protect the first non-return valve and thus prevent the main supply supporting combustion immediately downstream of the charging point, a swept band with an angle of not less than 90° and with a radius five times the outside diameter of the conducting pipe should be interposed immediately downstream of the charging point and filter (if fitted).

NOTE 2 Special care should be taken with piping geometry, so that if a burn through should occur at a feature such as a bend, the resulting torching flame should not impinge on nearby parts in such a manner as to exacerbate the hazard.

6.1.2 In-situ replenishment facilities provided for the primary system, shall be accessible from outside the aircraft and isolated from other service connections to prevent cross contamination.

6.1.3 The dimensions of replenishment couplings for the supply of liquid oxygen to aircraft shall be in accordance with BS C 5.

6.1.4 The dimensions of replenishment couplings for the supply of high pressure gaseous oxygen to aircraft shall be in accordance with BS C 16.

NOTE Very high pressure gaseous storage systems require special replenishment procedures. For such systems a different form of replenishment coupling should be used in conjunction with special replenishment equipment.

6.2 Equipment connections

6.2.1 On units having more than one connection, the unions shall be arranged to prevent incorrect connections.

6.2.2 Connections used only for servicing and testing shall be of a different type from those used for other purposes.

6.2.3 Connections shall be locked to prevent inadvertent disconnections.

6.3 Quick disconnection couplings

6.3.1 Quick disconnection couplings shall be capable of being made, locked and separated with gloved hands.

6.3.2 If the connection fails to lock, the two halves of the connection shall be self-separating and be installed to provide evidence of its malfunction to the user.

NOTE Self-sealing couplings should be designed to minimize oxygen spillage or leakage during coupling or uncoupling.

6.3.3 Where electrical connections are combined with the coupling, the oxygen circuit shall be complete and sealed before the electrical connections are made or broken.

7 Filters

7.1 Filters shall be provided at the replenishment point to prevent the ingress of particulate contaminants in accordance with the limits specified in BS N 3.

7.2 Filters shall be provided in oxygen system components to prevent contamination of, or damage to, valves and mechanisms. Filters shall be readily accessible for replacement or cleaning during overhaul.

NOTE In general, they should be provided immediately upstream of valves and controlling orifices.

8 Vent or relief devices

8.1 Pressure limiting devices for containers used for the storage of oxygen shall ensure that the pressure cannot rise above the proof pressure specified for the container.

8.2 Pressure limiting devices (e.g. relief valves) shall be provided to protect the system from pressure in excess of the component design limitations.

NOTE Excessive pressure may arise from failure of the normal regulating means.

8.3 In liquid oxygen systems at least two independent pressure limiting devices shall be provided. One of these devices shall be in direct communication with the container.

8.4 The discharge of oxygen arising from the operation of a relief device in a system shall be made overboard.

NOTE In the case of a gaseous system, if no hazard is created, the system may be discharged within the compartment in which it is installed.

8.5 All vent lines taking oxygen overboard shall be unrestricted and, apart from means to prevent the ingress of contamination, shall be free from U-bends and shall have a gravity fall to atmosphere to prevent the risk of blockage by ice.

9 Strength of materials

9.1 All parts of the system shall be designed to withstand the ultimate pressure to which they could be subjected in the event of a system failure. The ultimate pressure will vary throughout the system and shall be controlled by a pressure limiting device, duplicated where necessary.

9.2 Pipes, hoses and couplings of the system shall be designed to withstand:

- a) a design proof pressure of either $1.5 p_w$ or $1.125 p_r$, whichever is the greater, without leakage or permanent distortion greater than that permitted in the appropriate British Standard for the material; and
- b) an ultimate pressure of either $3 p_w$ or $2.25 p_r$, whichever is the greater, without fracture or bursting.

Where p_w and p_r are defined as follows:

- p_w is the normal maximum working pressure at the extremes of temperature for which that particular part of the system is designed;
- p_r is the relief pressure for that part of the system fixed at a value above p_w (usually $p_r = \text{approximately } 1.33 p_w$). Where a surge pressure greater than $1.1 p_w$ is experienced during operation of any service, this greater pressure should be used in place of p_w .

9.3 All other components shall be designed to withstand:

- a) a design proof pressure of $1.5 p_w$ or $1.125 p_r$, whichever is the greater, without leakage or permanent distortion greater than that permitted in the appropriate British Standard for the material; and
- b) an ultimate pressure of $2.0 p_w$ or $1.5 p_r$, whichever is the greater, without fracture or bursting.

9.4 The complete system shall be subjected to a test pressure equal to p_w , in accordance with Appendix B, to confirm that the leakage is within the design specification.

10 Cleaning processes

10.1 Soldering, brazing and welding

Components, which have been subject to soldering, brazing or welding, shall be cleaned to remove all traces of oil, grease and organic flux. Any flux used shall, when tested with materials in accordance with Appendix A, not affect the ability of the materials to comply with 4.1.3 to 4.1.5.

NOTE Fluxless jointing is preferred in order to eliminate these hazards.

10.2 Cleaning and purging

10.2.1 Before assembly all individual components shall be cleaned to remove dust, swarf, metallic particles, oil, grease, machining lubricant, fluxes, test liquids and any other organic contaminants.

NOTE It is essential that particular attention be paid to “blind” holes to prevent the inclusion of contaminants.

10.2.2 Where cleaning is necessary, assemblies or complete systems shall be purged with one of the gases given in Appendix B.

10.2.3 All external ports and pipe connections shall be protected against the ingress of contaminants.

11 Identification marking

11.1 Oxygen cylinders shall be marked with the following information:

- a) the symbols “O₂ (AV)” in stencilled lettering;
- b) the normal maximum working pressure at a stated temperature.

NOTE 1 Cylinders may in addition bear the name of the gas.

NOTE 2 There is no International Standard for colour coding of gas cylinders. It is normal UK practice for oxygen storage cylinders to be coloured black with a white 360° section at the valve end. In the USA the conventional colour for oxygen storage cylinders is green.

11.2 Pipelines shall be marked with identification symbols in accordance with BS M 23.