

AS 2896:2021



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Medical gas systems — Installation and testing of non-flammable medical gas pipeline systems



AS 2896:2021

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- Institute of Healthcare Engineering Australia
- Master Plumbers Australia and New Zealand
- NSW Health
- SA Health
- Therapeutic Goods Administration

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Medical gas systems — Installation and testing of non-flammable medical gas pipeline systems

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Preface

This Standard was prepared by the Standards Australia Committee HE-017, Medical Gas Systems, to supersede AS 2896—2011.

The objective of this Standard is to set out requirements for the safety aspects, construction, testing and certification, operation and maintenance of non-flammable medical gas pipeline systems (MGPS) used for patient care, operating surgical tools, and therapeutic and diagnostic purposes. Non-flammable medical gas pipeline systems include medical suction pipeline systems.

Some of the major changes in this Standard include:

- (a) Distinguishing Levels 1 and 2 installations, based on the complexity of the health care facility and required MGPS.
- (b) Addition of [Appendix K](#) — Roles and responsibilities, to assist healthcare facilities in determining the commissioning process for medical gas pipeline systems.
- (c) Addition of [Appendix M](#) — Commissioning plan for Levels 1 and 2 installations.
- (d) Use of non-medical gases in reticulated systems and requirements for the detection and prevention of leaks and cross connection have been considered.
- (e) Addition of a requirement to ensure that any change-over alarm signals cannot be cancelled without first replacing empty cylinders on auto change-over manifolds.
- (f) Revision of the pressure and flow performance requirements and testing.
- (g) Introduction of requirements for the testing of purity for medical and surgical tool air.
- (h) Back-up for special care locations.
- (i) Additional requirements for gas scavenging.

A high quality of workmanship and experience is essential in the installation of medical gas pipelines. For medical gases not listed in [Clause 1.2](#), special pipeline designs may be required which are not covered by this Standard. For certain situations, e.g. hyperbaric conditions, special design and performance criteria for pipelines may be required.

Requirements in this Standard may be used as a guide for piping systems for other non-flammable medical gases and anaesthetic gas scavenging systems, but variations in the requirements may be necessary.

The inclusion of roles and responsibilities in AS 2896:2021 was approved by the Standards Development Committee on 2 November 2017, as a one-off exemption to the directives of Standardization Guide 009: Preparation of Standards for Legislative Adoption.

The terms “normative” and “informative” have been used in this Standard to define the application of the Appendix to which they apply. A “normative” Appendix is an integral part of a Standard, whereas an “informative” Appendix is only for information and guidance.

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Introduction

Medical gas pipeline systems (MGPS) have some characteristic hazards, usually related to their original construction, modification, or repair rather than to problems arising during their working life. Medical gas pipelines are a life support system and as such require careful consideration of their design, construction and installation. Hazards include plumbing errors, use of materials incompatible with the gases to be delivered, obstruction of flow by material left in the pipelines, gas contamination by residual debris or accumulated foreign matter such as scale and organic contamination, and gas contamination due to chemical interaction between the gases and the pipeline components or foreign matter and condensation in pipelines. A particularly hazardous situation may occur when any amount of a hydrocarbon, such as oil, grease or other combustible compounds, comes in contact with oxidizing gases such as oxygen or nitrous oxide.

For this reason, this Standard contains requirements that procedures be taken to avoid gas pipeline hazards, such as —

- (a) provision of documentation of tests and results from those responsible for the construction to the healthcare facility and retained as part of the facility's permanent records; and
- (b) independent inspection of the system by the healthcare facility, using its own qualified personnel, or an experienced agent, who may be an independent outside contractor, to confirm and document the system's satisfactory operation.

The risks associated with the characteristic hazards as outlined above are increased where medical gases, apart from oxygen, medical air, surgical tool air or suction are reticulated in the healthcare facility or any MGPS where there are special care locations. For this reason the Standard has introduced the distinction between Level 1 and Level 2 works, on which further information can be found in [Appendix K](#). Levels 1 and 2 responsibilities checklists are detailed in [Table K.1](#) and [Table K.2](#) respectively.

Components of the medical gas system should be obtained and installed under the supervision of a person familiar with proper practices for its construction, installation and use. In order to establish competence of the personnel, the healthcare facility manager or operator should closely examine the previous experience of any contractor or installer proposing to work on or build a pipeline system. The healthcare facility manager or operator should also determine if the contractor or installer is familiar with the contents of this Standard, which should be specified in the construction agreement. Unless otherwise specified, changes to the Standard do not act retrospectively.

All companies involved in the design, installation, testing, commissioning, and maintenance of medical gas systems should have suitable quality management systems, e.g. AS/NZS ISO 9001.

The maintenance and servicing of the gas pipeline system is the responsibility of the healthcare facility but may be delegated.

NOTES

Australian Standard®

Medical gas systems — Installation and testing of non-flammable medical gas pipeline systems

Section 1 Scope and general

1.1 Scope

This Standard sets out requirements for the safety aspects, construction, testing and certification, operation and maintenance of non-flammable medical gas pipeline systems (MGPS) used for patient care, operating surgical tools, and therapeutic and diagnostic purposes. Non-flammable medical gas pipeline systems include suction pipeline systems used for human patient care.

The supply of oxygen from pressure swing absorption, oxygen concentrators and similar techniques is not covered in this Standard. The supply of synthetic air from proportioning units is not covered in this Standard.

The Standard does not apply to suction systems for laboratories and dental suction.

Some requirements are provided for the source of supply for the pipeline system as well as requirements for the pipeline system itself, terminal units and related warning systems.

The Standard also contains requirements for operating room services modules at which terminal units for medical gases are situated.

NOTE Patient care encompasses both medical and dental applications.

1.2 Application

This Standard applies to medical gases and suction services used in a MGPS.

The Standard applies to systems providing any of the following —

- (a) Oxygen;
- (b) Nitrous oxide;
- (c) Medical air;
- (d) Surgical tool air;
- (e) Carbon dioxide in oxygen ($\text{CO}_2 \leq 7 \%$);
- (f) Nitrous oxide/oxygen 50/50;
- (g) Helium/oxygen mixtures ($\text{O}_2 \geq 20 \%$);
- (h) Helium/oxygen mixtures ($\text{O}_2 < 20 \%$);
- (i) Helium;
- (j) Carbon dioxide;
- (k) Medical suction;

NOTE In this Standard, “suction” is the preferred term, and corresponds with the internationally known term “vacuum”.

- (l) Scavenging.

Where other gases or gas mixtures are reticulated in healthcare facilities together with any of those listed in this Clause, the following clauses shall apply as a minimum requirement to ensure safe operation, and in the case of non-medical gases, ensure non-interference with the MGPS:

- (i) [Clause 5.4.2](#), Visual check.
- (ii) [Clause 5.4.8](#), Check for cross connection in pipeline.
- (iii) [Clause 5.5.2](#), Total system pressure test.

Unless otherwise stated, all pressures in this Standard are gauge pressure, i.e. measured with reference to atmospheric pressures, and not absolute pressure. In the case of suction pressures, the smaller the number the higher the gauge pressure, that is, closer to atmospheric pressure and therefore weaker suction (i.e. -50 kPa is weaker suction than -60 kPa, and -70 kPa is stronger suction than -60 kPa).

1.3 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

NOTE Documents for informative purposes are listed in the Bibliography.

AS 1210, *Pressure vessels*

AS 1319, *Safety signs for the occupational environment*

AS 1345, *Identification of the contents of pipes, conduits and ducts*

AS 1349, *Bourdon tube pressure and vacuum gauges*

AS 1432, *Copper tubes for plumbing, gasfitting and drainage applications*

AS 1668.2, *The use of ventilation and airconditioning in buildings, Part 2: Mechanical ventilation in buildings*

AS 1721, *General purpose metric screw threads*

AS 1894, *The storage and handling of non-flammable cryogenic and refrigerated liquids*

AS 2473.3, *Valves for compressed gas cylinders, Part 3: Outlet connections for medical gases (including pin-indexed yoke connections)*

AS 2568, *Purity of medical air produced from on-site compressor systems*

AS 2625.1, *Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts, Part 1: General guidelines*

AS 2625.4, *Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts, Part 4: Industrial machines with nominal power above 15 kW and nominal speeds between 120 r/min and 15 000 r/min when measured in situ*

AS 2700, *Colours standards for general purposes*

AS 2902, *Medical gas systems — Low pressure flexible hose assemblies*

AS 3688, *Water supply and gas systems — Metallic fittings and end connectors*

AS 4041, *Pressure piping*

AS 4332, *The storage and handling of gases in cylinders*

AS 4706, *Pressure gauges for regulators used with compressed gas cylinders*

AS/NZS 1167.1, *Welding and brazing — Filler metals, Part 1: Filler metal for brazing and braze welding*

AS/NZS 1571, *Copper — Seamless tubes for airconditioning and refrigeration*

AS/NZS 2107, *Acoustics — Recommended design sound levels and reverberation times for building interiors*

AS/NZS 2865, *Safe working in a confined space*

AS/NZS 3000, *Electrical installations (Australian/New Zealand Wiring Rules)*

AS/NZS 3003, *Electrical installations — Patient areas*

AS/NZS ISO 31000, *Risk management — Principles and guidelines*

ISO 7396-1, *Medical gas pipeline systems — Part 1: Pipeline systems for compressed medical gases and vacuum*

ISO 8573-1, *Compressed air — Part 1: Contaminants and purity classes*

ISO 10524 (all parts), *Pressure regulators for use with medical gases*

ISO 15001, *Anaesthetic and respiratory equipment — Compatibility with oxygen*

ISO 18082, *Anaesthetic and respiratory equipment — Dimensions of non-interchangeable screw-threaded (NIST) low-pressure connectors for medical gases*

ISO 21969, *High-pressure flexible connections for use with medical gas systems*

EUROPEAN DIRECTORATE FOR THE QUALITY OF MEDICINES AND HEALTHCARE. *European Pharmacopoeia*. Council of Europe, Ninth Edition, 2016

1.4 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

1.4.1

alarm system

system comprising sensors, one or more indicating panels, power supply and interconnecting wiring, which continuously monitors the status of a MGPS and notifies of variance outside set limits

1.4.2

anaesthetizing locations

locations within a healthcare facility where anaesthesia services requiring inhalational anaesthesia are likely to be required

1.4.3

asphyxiant gas

gas and gas mixtures that cannot sustain human life if inhaled continuously

Note 1 to entry: Nitrous oxide, carbon dioxide, nitrogen, helium, and helium/oxygen mixtures ($O_2 < 20\%$) are examples of asphyxiant gases.

Note 2 to entry: For examples of asphyxiant gases refer to safety data sheets.

1.4.4

auxiliary supply connector

gas-specific male sleeve index system (SIS) or non-interchangeable screw terminal (NIST) end fitting

1.4.5

birthing area

rooms which provide facilities for the entire birthing process including patient assessment and preparation, management of labour, delivery and infant clean-up, resuscitation and post-natal recovery and observation

[SOURCE: Australian Health Facility Guidelines, wording modified]

1.4.6**building commissioning**

completion for occupation by the contractor from a physical facility point of view such as successful running of all plant and equipment

1.4.7**central supply**

supply which is a bank of gas cylinders, a cryogenic liquid supply, a system using compressors with or without a bank of gas cylinders, or a system using suction pumps

1.4.8**connector**

gas-specific female or male sleeve index system (SIS) or non-interchangeable screw terminal (NIST) end fitting, permanently attached to one or both ends of a flexible hose assembly or brazed to a pipeline

1.4.9**control equipment**

items such as pressure regulators, relief valves, alarm initiators, manual and automatic valves, necessary to maintain gas supplies at a set pressure within the pipeline distribution system

1.4.10**cryogenic liquid system**

system incorporating one or more liquid supplies, the storage pressure of which is thermally controlled, consisting of a primary and secondary supply which is liquid, and an emergency supply which may be gaseous

Note 1 to entry: The secondary supply is usually the residual cryogenic liquid below a pre-determined level.

1.4.11**design flow rate**

estimation of the MGPS operating flow requirements ensuring adequate performance to all terminal units

1.4.12**diversity factor**

factor which represents the maximum proportion of terminal units in a defined clinical area which will be used at the same time at defined flow rates (see [Appendix A](#))

1.4.13**emergency gas supply**

that portion of the source of supply which is immediately available to continue supply and is the last source of supply in a system

1.4.14**essential power supply**

electrical energy provided from an alternative source to the normal power supply (e.g. from duplicate supply mains or generator set) which may be subjected to a minor supply break due to switching or starting the generator

1.4.15**extra-low voltage****ELV**

electric voltage not exceeding 50 V alternating current or 120 V direct current

1.4.16**ferrule**

non-reusable portion of a hose end fitting

1.4.17**gas-specific**

unique characteristics for a specific gas

Note 1 to entry: Characteristics such as colour identify pipelines and terminal units of different gases. Characteristics such as design of connection interfaces reduce unintended connections between different gas services.

1.4.19**healthcare facility manager**

person that is responsible for the non-clinical operations at a healthcare facility

1.4.20**healthcare facility operator**

person that is responsible for the overall operations of the healthcare facility

1.4.21**healthcare facility representative****HFR**

person authorized by the healthcare facility to carry out or supervise testing and checking

Note 1 to entry: There are multiple levels of this role which are defined in [Appendix K](#).

1.4.22**hose**

gas-specific, flexible tube suitable for medical gases

1.4.23**isolation valve**

manual or automatic valve which when closed, prevents flow in either direction

Note 1 to entry: Isolation valves are often referred to as shut-off or zone isolation valves.

Note 2 to entry: Depending on its location and function in the medical gas system, an isolation valve may be referred to as main, secondary and the like.

1.4.24**level 1 works**

works performed on part of a MGPS where asphyxiant gases, are reticulated, or any part of a MGPS where there are special care locations

1.4.25**level 2 works**

works performed on part of a MGPS where the only reticulated gas services are a combination of either oxygen, medical air, surgical tool air or suction, and where there are no special care locations

1.4.26**line pressure relief valve**

valve to protect the pipeline downstream of secondary (line pressure) regulators

Note 1 to entry: This term is sometimes used interchangeably with the term safety relief valve

1.4.27**medical air**

normal air of the lower atmosphere entering a medical air pipeline system with a purity as defined in AS 2568 where supplied from medical air compressor systems, or as defined in the European Pharmacopoeia where supplied from gas cylinders

1.4.28**medical air compressor system**

air compressors with associated equipment as a source of supply, designed to provide medical air to a MGPS at a constant pressure

1.4.29 medical gas pipeline system MGPS

central supply of medical gases with control equipment and a distribution pipeline linking the source of supply to the terminal units (see [Figure 1.1](#))

Note 1 to entry: This includes pump suction and venturi ejector operated suction systems.

Note 2 to entry: This includes isolation valves, pressure relief valves, and any secondary pipeline pressure regulators.

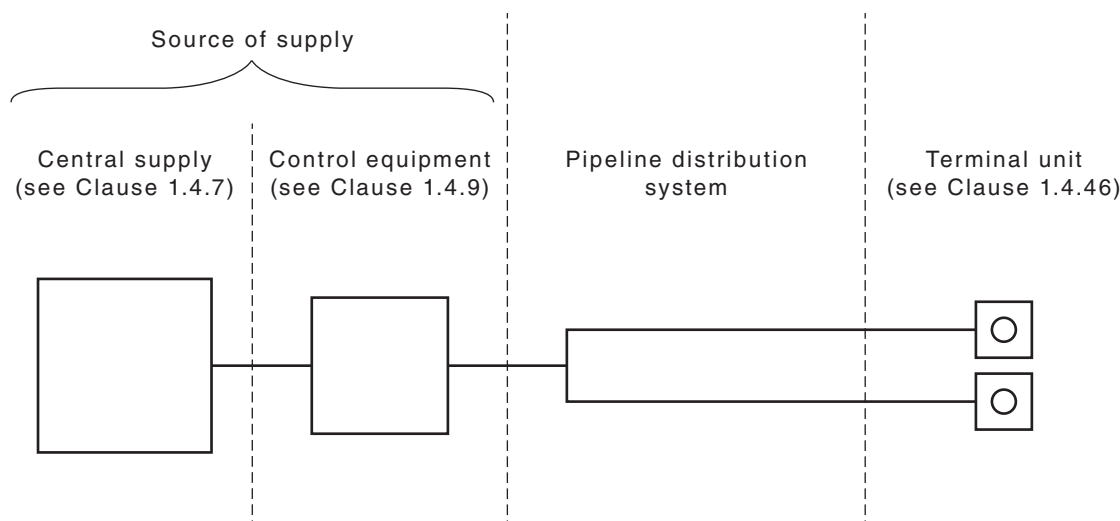


Figure 1.1 — General layout of a MGPS

1.4.30 non-return valve

valve which permits flow in one direction only

1.4.31 occluded suction

pressure achieved at a suction terminal unit under no-flow conditions

1.4.32 operational commissioning

preparation of a facility and its staff for commencement of operation, such as equipping and familiarizing staff with facility operation

1.4.33 pressure measurement

unless otherwise stated, all pressures are gauge pressure P_g (i.e. measured with reference to atmospheric pressures) and not absolute pressure

Note 1 to entry: In the case of suction pressures, the smaller the number the higher the gauge pressure, which is, closer to atmospheric pressure and therefore weaker suction; (i.e. -50 kPa is weaker suction than -60 kPa, and -70 kPa is stronger suction than -60 kPa).

1.4.34 primary gas supply

that portion of the source of gas supply (see [Clause 1.4.42](#)) which is supplying the system during normal operation

1.4.35**pressure regulator**

device which reduces the inlet pressure and maintains the set outlet pressure within specified limits

Note 1 to entry: Depending on its location and function in the MGPS, a pressure regulator may be referred to by its location, e.g. primary, secondary, source, main.

1.4.36**primary pressure relief valve**

valve to relieve pressure downstream of a primary pressure regulator

Note 1 to entry: In practice, this term may be used interchangeably with safety relief valve

1.4.37**self-sealing valve**

valve which remains closed until opened by the attachment of an appropriate connector

1.4.38**service facility**

connection which only functions as a source of supply when service is being carried out or in the event of an emergency

1.4.39**service head**

that part of the services module containing the services accessible to the user

1.4.40**services modules****1.4.40.1****fixed services module****FSM**

services module containing medical gas terminal units and potentially mains electricity, communications, monitoring and extra-low voltage services

Note 1 to entry: The outlet location is not adjustable in relation to the building structure. FSMs may be wall, medical services panel (MSP), column or pedestal mounted and may contain flexible hoses with NIST fittings.

1.4.40.2**articulated services module****ASM**

services module containing medical gas terminal units and potentially mains electricity, communications, monitoring and extra-low voltage services

Note 1 to entry: Adjustable position imposes additional requirements in comparison to fixed terminal unit modules (e.g. flexible hoses, movement stops, braking mechanisms). Depending on the point of attachment to the building, these are commonly termed pendants or booms although these terms are not standardized.

1.4.41**sleeve index system****SIS**

gas-specific system for connecting a medical device to the terminal unit of a MGPS

Note 1 to entry: Gas specificity is achieved by the diameter of a circular sleeve engaging with a circular groove and held by a specific thread as specified in AS 2902.

1.4.42**source of supply**

central supply and associated control equipment including bulk cryogenic vessels, cylinder manifolds, compressors, suction pumps, receivers, dryers, filters and control equipment, up to, but not including, the main isolation valve and line pressure relief valve

1.4.43**special care locations**

locations where patients are dependent on specific gases such as oxygen, nitrous oxide, medical air, medical suction, e.g. anaesthetizing area, recovery room, coronary care unit

1.4.44**suction system**

suction pumps with or without a receiver as a source of supply

1.4.45**surgical tool air**

high pressure medical air which is used only as a power source for surgical applications

1.4.46**terminal unit**

gas-specific outlet (inlet for suction) in a MGPS at which the user makes connection or disconnection

1.4.47**uninterruptible power supply****UPS**

electrical supply system arranged so that failure of the normal supply does not cause any immediate loss of supply to the installation

Note 1 to entry: These supplies may be either an essential power supply with an additional battery backed supply which results in no loss of power during establishment of the essential power supply, or supplies powered by batteries which are trickle charged from the essential power supply.

Section 2 Source of supply

2.1 General

Supply systems with forms of construction different from those detailed in [Appendix L](#) may be presumed to be in conformance with the safety and performance objectives of this Standard if it can be demonstrated that an equivalent degree of safety and performance is obtained.

Evidence of an equivalent degree of safety shall be provided by the installer or contractor to the administration of the healthcare facility operator.

2.2 Source of supply

The source of supply shall be one or a combination of —

- (a) a system of cylinders and necessary supply equipment assembled as described in [Clause 2.4](#);
- (b) a cryogenic liquid supply system in accordance with [Clause 2.8](#);
- (c) a medical air system as described in [Clause 2.9](#);
- (d) a medical suction system as described in [Clause 2.10](#); or
- (e) a surgical tool air system as described in [Clause 2.11](#).

The source of supply shall be protected from over-pressurization as described in [Clause 2.7](#).

2.3 Provision in case of failure of supply

2.3.1 Special care locations

For MGPS in special care locations, a dedicated emergency supply of the dependent gas or gases shall be available (see [Figure L.1](#)). In special care locations where patients are ventilated, an oxygen emergency supply shall be provided. For locations where neonatal patients are ventilated, both medical air and oxygen emergency supplies shall be provided.

The emergency supply shall be connected upstream of the zone isolation valve box of the special care location. An emergency gas supply alarm shall be provided. The capacity of the emergency gas supply shall be such that it automatically continues to supply at maximum flow rate for the area covered by that valve box. Each healthcare facility shall ensure that the emergency gas supply duration is sufficient to ensure patient safety until an alternative source can be provided for affected locations.

NOTE 1 In operating rooms, the emergency supply requirement is met by the reserve (emergency) oxygen cylinder on an anaesthetic machine.

NOTE 2 Gas consumption should be estimated as 40 L per minute per ventilated patient outside operating rooms.

NOTE 3 For further requirements regarding internal cylinder storage see [Clause 2.13.2](#).

NOTE 4 A risk assessment performed by the healthcare facility should determine the time required for the local emergency gas supply to continue. The absolute minimum should be 10 min.

2.3.2 Service facility inlets

All medical gas supply systems shall include a service facility inlet for connecting a temporary auxiliary source of supply in emergency or major maintenance situations (see [Figure L.3](#)).

The service facility inlet shall be located in the pipeline distribution system, remote from the primary source of supply. It shall be downstream of the primary source of supply isolation valve. There shall be a non-return valve between the service facility inlet and the primary source of supply isolation valve.

The service facility inlet shall be located so there is easy access for connection of a temporary auxiliary source of supply (such as mobile compressor, cryogenic liquid system, cylinders or cylinder packs). It shall be physically protected to prevent tampering and unauthorized access. It shall have a gas-specific supply connector.

The rated design flow capacity of the service facility inlet shall be indicated on a label on the inlet assembly. For an existing MGPS where the design flow capacity of the service facility inlet is not specified, the design flow rate capacity should be considered to be the pipeline design flow rate (as calculated from [Appendix A](#)) with a 50 % diversity factor applied. To achieve this flow capacity, a service facility inlet may require multiple supply connectors installed.

2.4 Cylinder supply systems

2.4.1 General

The cylinder supply system shall consist of an automatic change-over manifold with both working (primary) side and a secondary side of the manifold, each containing a minimum of three working days supply, unless delivery schedules indicate that greater volumes should be held.

NOTE 1 The guidelines for design flow given in [Tables A.1](#), [A.2](#) and [A.3](#) may be used in determining the number of cylinders required.

NOTE 2 For liquified gases see [Clause 2.4.10](#).

NOTE 3 Because primary and secondary supplies alternate with each other in a cylinder supply system, an additional emergency supply is not essential. However, in some situations, such as when special care locations need oxygen and/or medical air cylinder supplies, an emergency supply provision may be appropriate. Such an emergency supply may be used to maintain gas supply during manifold servicing.

2.4.2 Manifold

[Clause 2.4.2](#) applies to all new and existing manifolds.

Materials used in cylinder manifolds shall be compatible with oxygen at the maximum developed pressure and temperature of the cylinder contents.

All piping shall be copper or copper alloys, or other materials which have been proven suitable for oxygen service, at the maximum inlet working pressure of 20 000 kPa (refer to AS 2473.3).

All manifolds shall be installed in accordance with manufacturer's instructions and commissioned according to the requirements of [Clause 5.6.3\(a\)](#) prior to first use, or following any modification.

All existing manifolds which do not conform to the requirements of this Standard, including those rated at lower maximum inlet working pressure less than 20 000 kPa, or which conform but are beyond repair, shall be replaced or modified to conform, and then commissioned according to the requirements of [Clause 5.6.3\(a\)](#).

NOTE 1 This requirement operates retrospectively due to the risk to health and safety that non-conforming manifolds represent.

All existing manifolds which conform to the requirements of this Standard shall be inspected in accordance with [Clause 6.3.3](#). Where any maintenance is carried out, its operation shall be verified using the methodology outlined in [Clause 5.6.3](#) and [Clause 5.6.4](#) prior to being put back into service.

After maintenance, the function of the manifold shall be verified in accordance with [Clause 6.3.2](#).

NOTE 2 The verification of the function of the manifold does not require a gas identity test of the MGPS.

The manifold shall be connected to the gas supply cylinders by flexible leads manufactured in accordance with [Clause 2.4.9](#). [Figure 2.1](#) shows a typical manifold/cylinder connection.

The assembled manifold shall be leak-tested after installation, using full cylinders.

There shall be no discernible leakage allowed on this type of equipment when using a suitable leak-detection solution.

Manifolds shall be proven suitable for oxygen use and supplied cleaned and sealed from their manufacturer.

NOTE 2 Supply of gas to the manifold should be from cylinders correctly stored and handled according to instructions from the gas supplier and handled in the facility according to [Clauses 2.12](#) and [2.13](#). AS 4332 provides requirements and guidance on the storage and handling of gas cylinders.

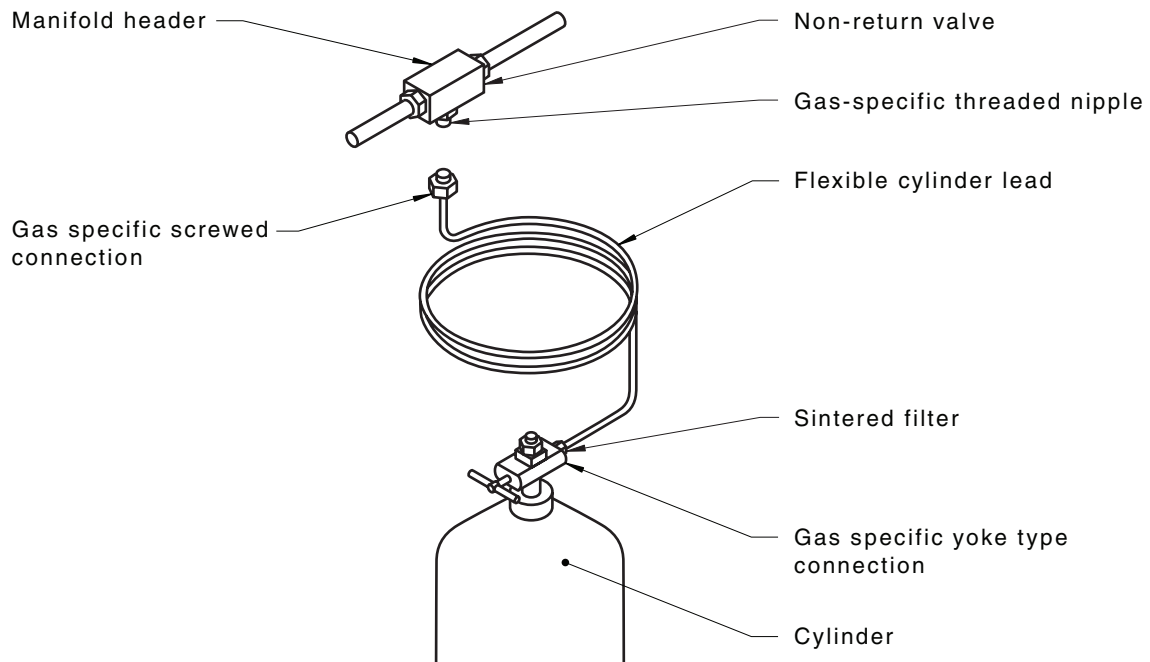


Figure 2.1 — Typical manifold and cylinder connection incorporating non-return valve

2.4.3 Manifold isolation

The manifold system shall be provided with an isolation valve in the low pressure reticulation piping. A service facility connection shall be provided for use during manifold maintenance or in the event of failure of the manifold pressure regulators.

2.4.4 Manifold reset

The manifold shall, in a single action, reset both the primary and secondary sides to their alternative supply pressures.

2.4.5 Manifold headers

Each cylinder connected to the system shall be provided with an individual header block incorporating a non-return valve to minimize the rapid loss of gas in the event of cylinder lead failure. Each header shall have a gas-specific threaded nipple compatible with the connection of the cylinder lead as specified in [Figure 2.2](#).

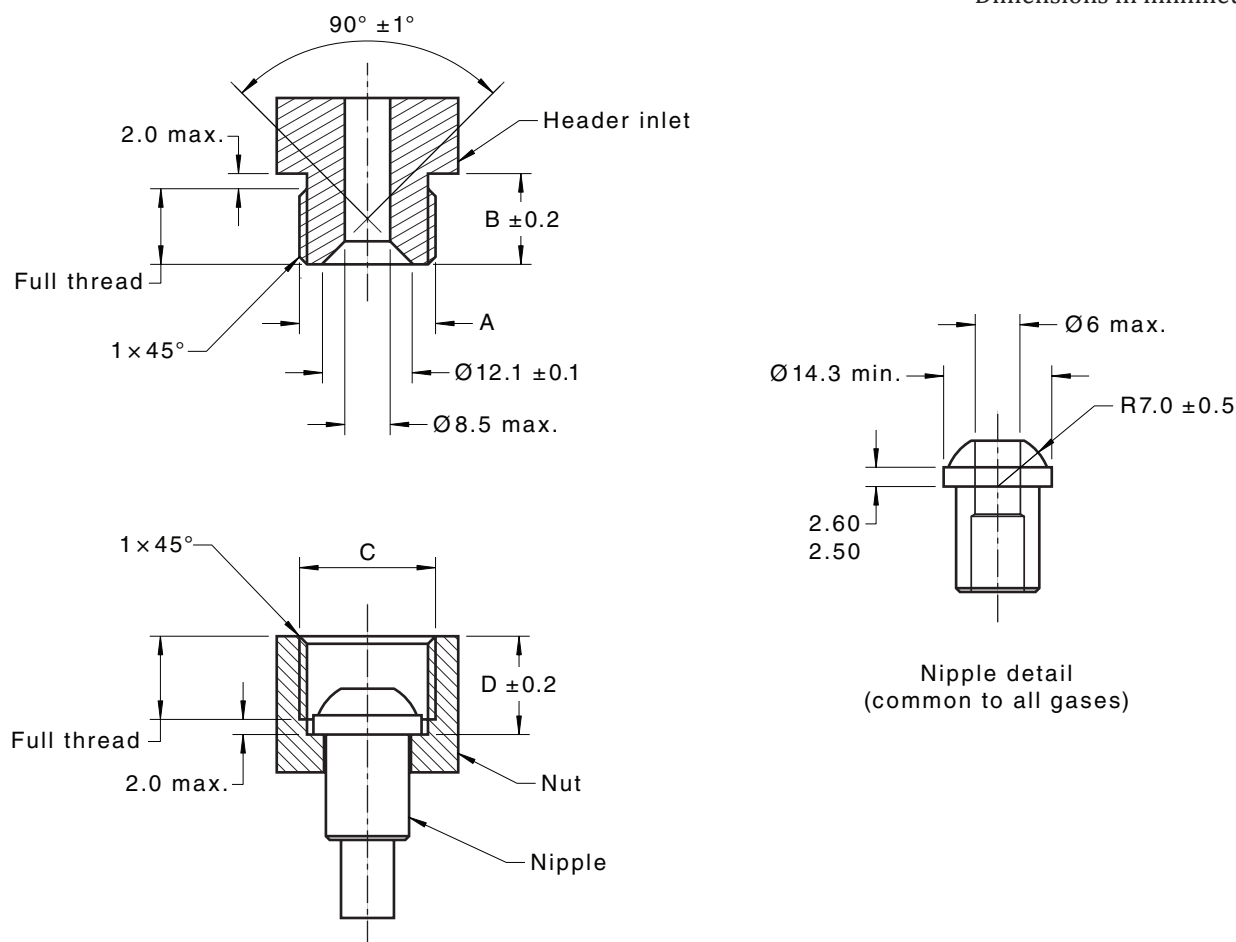
All valves in the high pressure side in a MGPS shall be slow opening so that velocity surges are not introduced into the pipeline.

NOTE 1 Ball and butterfly valves are not suitable on the high pressure side, prior to the first stage pressure regulator.

A small back flow through the non-return valve on the manifold header block is permitted to allow the pressure on a bank to equalize in the event of an empty cylinder being accidentally fitted when changing or if for some reason all cylinders on a supply bank are not changed at the same time, or are not of uniform pressure upon supply.

NOTE 2 It is recommended that all empty cylinders are changed at the same time.

Dimensions in millimetres



Header inlet and nut threads according to AS 1721				
Gas	Header inlet		Nut	
	Dimension "A" (mm)	Dimension "B" (mm)	Dimension "C" (mm)	Dimension "D" (mm)
Nitrous Oxide	M16 × 1.5 — 4h	11	M16 × 1.5 — 5h	12
Oxygen	M18 × 1.5 — 4h	12	M18 × 1.5 — 5h	13
Medical air, surgical tool air	M20 × 1.5 — 4h	13.5	M20 × 1.5 — 5h	14.5
Helium/oxygen mixtures (O ₂ ≥ 20 %)	M22 × 2.0 — 4h	15.5	M22 × 2.0 — 5h	16.5
Nitrous oxide/oxygen 50/50	M24 × 1.5 — 4h	16	M24 × 1.5 — 5h	17
Carbon dioxide	M26 × 1.5 — 4h	17	M26 × 1.5 — 5h	18
Carbon dioxide in oxygen (CO ₂ ≤ 7 %)	M28 × 1.5 — 4h	18	M28 × 1.5 — 5h	19

Figure 2.2 — Header with gas-specific threaded inlet for connection of cylinder lead

2.4.6 Manifold control panel

The control panel shall contain provision for selection of the primary and secondary bank of cylinders and contain clear operating instructions.

2.4.7 Cylinder racks

The cylinders on a manifold shall be mounted upright in a rack with safety retaining chains or straps.

2.4.8 Marking of maximum working inlet pressure on the manifold

The maximum working pressure shall be prominently marked on the manifold. For manifolds intended for high pressure permanent gases, e.g. oxygen and medical air, the manifold shall also indicate the corresponding cylinder settled pressure at 15 °C.

The maximum working pressure shall also be marked on cylinder leads and modular headers.

2.4.9 Cylinder lead

Each gas supply cylinder shall be connected to the manifold system by a replaceable flexible lead, manufactured from materials which are compatible with the gas as defined in ISO 15001, and suitable for the pressures and service conditions involved. High pressure flexible leads for oxidizing gases shall not ignite or show internal scorching when subjected to oxygen pressure shocks according to the test method in ISO 21969.

Only metallic leads shall be used for gases covered by this Standard, with the exception of CO₂ where non-metallic flexible leads may be used.

Non-metallic and corrugated metallic flexible leads shall be fitted with a restraining cable or equivalent to prevent “hose whip” in the event of lead failure. Where internal restraining cables are used, the leads shall be labelled to indicate this. For leads without this label, an external restraining cable shall be fitted.

At the header block end, the lead shall have a brazed-on or otherwise permanently attached ferrule and a gas-specific nut, in accordance with [Clause 2.4.5](#) and [Figure 2.2](#).

At the cylinder end, the lead shall have a brazed-on or otherwise permanently attached gas-specific, yoke-specific connection in accordance with AS 2473.3.

All leads shall have a 100 µm or less sintered filter, constructed from a copper base alloy fitted to the inlet of the yoke connection.

NOTE 1 Copper base alloy includes Monel, copper, brass or bronze materials.

A label shall be attached to the lead stating the gas, the maximum working pressure and date of manufacture.

NOTE 2 Cylinder leads should be replaced in accordance with manufacturer's instructions where provided.

2.4.10 Liquefied gases in cylinders

For gases which are liquefied in cylinders, such as nitrous oxide and carbon dioxide, there are limitations on the maximum withdrawal rate of gas per cylinder. At an ambient temperature of 20 °C the maximum recommended withdrawal rate is one-tenth of the cylinder contents per hour. This maximum withdrawal rate, together with the design flow, should be used to determine how many cylinders are needed to be installed on a manifold system.

NOTE For Australian “G” sized cylinders, one-tenth of the contents per hour roughly equates to 30 L/min.

2.4.11 Manifold alarm system

An alarm system shall be fitted to the manifold to signal cylinder bank change-over and low line pressure. Pressure switches or transducers used by the alarm system shall not be able to remain under pressure when isolated from the manifold system. The alarm system shall be configured such that if the renew alarm is cancelled without changing the empty cylinders, an “on emergency supply” alarm will trigger when the remaining capacity reaches 25 % of the total capacity of the manifold. Details of alarm system requirements are in [Section 3](#).

NOTE 1 Patient safety is compromised if an alarm can be cancelled without replacement of empty cylinders. This scenario would permit depletion of both cylinder banks without warning resulting in no gas supply to the MGPS once the second bank has been exhausted/consumed.

NOTE 2 “On emergency supply” alarm will require wiring of switch contacts on either side of the manifold. Individual gas alarm systems may be wired differently to achieve this outcome.

NOTE 3 For gases which are liquified in cylinders such as nitrous oxide and carbon dioxide there are no requirements for the “on emergency supply” alarm.

2.5 Pressure regulators

Pressure regulators shall conform with the relevant design and testing requirements of the ISO 10524 series.

Source, main and secondary pipeline pressure regulators (where fitted) shall together be capable of maintaining the required pressure when delivering flows in accordance with [Clause 3.4.2](#).

NOTE 1 External frosting and possible internal moisture condensation in the pressure regulators or associated pipework may result from high flow conditions in excess of design capacity. Heating should be avoided unless in accordance with manufacturer instructions.

A filter shall be inserted in the line upstream of the pressure regulator.

NOTE 2 The filter may be incorporated in the design of the pressure regulator.

NOTE 3 Outlet pressures from the ISO 10524 series pressure regulators may not correspond to those specified in this Standard, especially for surgical tool air.

2.6 Design of gas control systems

Control systems shall be designed so that pressure regulators, relief valves, non-return valves, safety valves, alarm pressure switches and change-over mechanisms can be maintained and serviced without interrupting gas supply to the MGPS.

All supply systems shall have a service facility, as specified in [Clause 2.3.2](#), placed so that appropriate access is achieved for connection by alternate sources of supply such as mobile compressors, manifolded cylinders or a cryogenic liquid system (see [Figure L.3](#)). This service facility shall be protected against unauthorized access.

2.7 Pressure relief valves

2.7.1 Primary pressure relief valve

A primary pressure relief valve shall be installed downstream of the first pressure regulator in each supply line where the service pressure exceeds 2 000 kPa. It shall be capable of protecting line pressure regulators from pressures exceeding design limits.

2.7.2 Line pressure relief valve

A line pressure relief valve shall be set to lift at a pressure of between 30 % and 40 % above nominal working pressure. The line pressure relief valve shall not allow the pressure within the system to exceed 100 % above nominal working pressure under any single fault condition (see [Figure 2.3](#)).

Pressure in percentage of nominal working pressure	
— 200 —	— Maximum pressure relief valve full discharge
— 140 —	— Maximum pressure relief valve lift
— 130 —	— Minimum pressure relief valve lift
— 120 —	— (Overpressure alarm, if fitted)
— 110 —	— Maximum working pressure
— 100 —	— Nominal working pressure
— 90 —	— Minimum working pressure
— 80 —	— Minimum under pressure alarm

Figure 2.3 — Pressure relief valve and alarm settings

The distribution system shall always be in continuity with a line pressure relief valve as shown in [Figures L.2, L.4, L.5, L.6, L.7, L.8, L.9, L.10 and L.11](#).

One method of achieving functional continuity is by duplication with a 3-way T-ported valve, with no “off” position as shown in [Figures L.2, L.4, L.5, L.6, L.7, L.8, L.9, L.10 and L.11](#). Three way valves used for twin line pressure relief valve shall be of the type which allows the engagement of one or both line pressure relief valves through the entire rotation of the valve handle, i.e. no centre off position that would isolate both line pressure relief valves from the MGPS. The purpose of this relief valve is to protect patients and equipment attached to the terminal unit from excess pressure.

2.7.3 Exhausts

Exhausts from relief valves shall be vented to a safe place in accordance with AS 1668.2.

2.8 Cryogenic systems

2.8.1 General

The cryogenic supply system shall consist of at least three sources of supply, including primary, secondary and emergency supply. Examples of the systems are shown in [Figures L.4, L.5 and L.6](#).

NOTE The use of bulk liquid oxygen reduces the risks associated with handling oxygen cylinders and should be considered when high demand is likely.

2.8.2 Secondary supply

The secondary supply, which is contained within the liquid oxygen cryogenic vessel, shall contain at least three days' requirements unless delivery schedules indicate that greater volumes shall be held.

2.8.3 Emergency supply

The emergency supply shall contain a minimum of 24 hour requirements unless delivery schedules indicate that a greater volume shall be held. The supply shall be arranged so that, when operating, the gas supply to the pipeline distribution system can be maintained indefinitely without interruption and arranged so that the pipeline pressure is maintained within the limits specified in [Clause 3.4.2](#).

The emergency supply shall consist of at least one of the following systems:

- (a) A cylinder manifold containing at least two banks of cylinders.
- (b) A system of permanently manifolded cylinders contained in road trailers or packs.

For cryogenic systems as described in (a) and (b), the contents of the emergency supply shall be monitored continuously and activate an alarm on the warning system when a loss of 25 % of contents is detected.

- (c) A system of cryogenic vessels or containers.

For cylinder systems as described in Item (c), the contents of emergency supply shall be monitored continuously and activate an alarm on the warning system when the contents fall below 30 % of the vessel capacity or at a level equivalent to 18 hours of supply, whichever is greater.

2.8.4 Primary main check valve

Cryogenic supply systems shall have a non-return valve in the primary pipeline, upstream of the point of intersection with the emergency service facility.

2.8.5 Cryogenic liquid vessel connections

Cryogenic liquid vessel fill connections shall be gas-specific and non-interchangeable between services to avoid liquid nitrogen or argon being filled into a liquid oxygen vessel, or vice versa. Adaptors shall not be used.

2.9 Medical air systems

2.9.1 General

The source of supply for medical air shall supply air of a minimum purity depending on its source as follows:

- (a) Supplied by a medical air compressor system which conforms with AS 2568.
- (b) Supplied by a cylinder supply system which conforms with the European Pharmacopoeia.

The source of supply for medical air shall be one of the following:

- (i) An air compressor system as specified in [Clause 2.9.2](#) and as shown in [Figures L.7, L.8, L.9 and L.10](#), and that is connected to an essential power supply.
- (ii) A cylinder supply system in accordance with [Clause 2.4](#) and as shown in [Figure L.2](#).
- (iii) A combination of items (i) and (ii) using a compressor as shown in [Figure L.11](#), and an auto change-over manifold in accordance with [Clause 2.4](#).

The source of supply for medical air shall be independent of the source of supply for surgical tool air.

If medical air is provided for other purposes, such as operation of ceiling articulated services modules, anaesthetic gas scavenging systems, or medical air for medical personnel, the flow requirements of these applications shall be taken into account by the designer/installer of the system.

Means shall be provided to prevent back flow into the pipeline.

Medical air shall not be provided for applications such as general workshop use, motor repair workshop use, spray painting, tyre inflation, reservoirs for pressurization of hydraulic fluids, or pneumatic control of air conditioning, which may impose unforeseen demands and could compromise the availability or quality of air for normal patient care purposes.

2.9.2 Medical air compressor-only source of supply

2.9.2.1 General

Medical air compressors shall supply medical air of a minimum purity as specified in AS 2568.

A compressor-only central supply system shall comprise a minimum of two medical air compressors, preferably identical. The system shall have the capacity to meet or exceed the design flow rate with any one compressor out of operation, i.e. a source comprising two compressors shall have the capacity to meet or exceed the design flow rate with one compressor operating; a source comprising N compressors shall have the capacity to meet or exceed the design flow rate with (N-1) compressors operating.

NOTE 1 Design flow rates may be derived from [Table A.2](#), [Appendix A](#).

Multiple compressor installations shall have each compressor capable of isolation, both electrically and mechanically, so that failure of one compressor shall not interfere with the correct operation of the remaining plant. The connection of each compressor shall be designed to ensure that isolation of services to a failed compressor such as power, cooling and air treatment cannot interfere with the correct operation of the remaining plant.

NOTE 2 The installation of more than two compressors is recommended because of the possible large difference between maximum and minimum flow requirements causing inefficient running of a large compressor with an excessive number of starts during normal demand (i.e. less than the maximum design). The use of three compressors, each sized at 50 % of the maximum design capacity, would reduce this inefficiency and the number of starts per hour to satisfy normal demand. Similarly, the size of the air receiver could then be reduced to adhere to the requirement for maximum number of starts per hour.

Compressors shall be manufactured and installed in accordance with the electrical requirements of AS/NZS 3000.

Noise generated from the medical air compressor plant shall not cause sound pressure levels in adjacent areas to exceed levels specified in AS/NZS 2107.

Vibration generated from the medical air compressor plant shall not exceed the levels specified in AS 2625.1 and AS 2625.4.

In order to guarantee purity of medical air where supplied by water-sealed compressors, appropriate eliminators shall be installed for water droplets, solids and aerosols. Compressors with oil-lubricated compression chambers shall not be used.

NOTE 3 If a water-sealed compressor has not been used on a daily basis, microbiological checks should be performed before it is recommissioned.

Polytetrafluoroethylene piston rings may be used provided that the compressor is fitted with an excess air temperature alarm and automatic shutdown control so that the operating temperature does not exceed that specified for such rings by the manufacturer (see [Clause 2.9.2.9](#)).

Each compressor shall display a safety label with the words "CAUTION: THIS MACHINE IS REMOTELY CONTROLLED AND STARTS WITHOUT WARNING", or words to that effect.

Equipment used for continuous gas monitoring shall be capable of measuring the concentration of the nominated constituent gas to an accuracy of $\pm 1\%$ of the reading, and be calibrated at the manufacturer recommended period, or every 12 months, whichever is the lesser (see [Clause 6.4.2](#)).

Medical air supply systems shall include a service facility inlet as specified in [Clause 2.3.2](#).

2.9.2.2 After-coolers

After-coolers capable of cooling compressed air to within 15 °C of the temperature of the cooling medium should be installed between each compressor and the air receivers.

After-coolers, if installed, shall be fitted with an automatic drain trap complete with a bypass for manual draining.

2.9.2.3 Air receivers

One or more air receivers conforming with the design requirements of AS 1210 shall be installed in the system. To ensure continuity of medical air supply when the receiver is shut down for survey or maintenance, a manual valve bypass facility shall be installed.

NOTE Examples of bypass facilities can be found in [Appendix L](#).

Protective coatings shall not be applied to the internal surface of air receivers.

2.9.2.4 Air dryness

The requirements and recommendations for air dryness are as follows:

- (a) *Air drying* — Medical air shall be dried by duplex driers to a level conforming with AS 2568. The performance of the driers shall be such that dryness can be achieved with one drier removed for servicing.

NOTE This degree of dryness is sufficient to prevent condensation in reticulation piping and to prevent valves sticking in anaesthetic machines and respirators.

- (b) *Alarms* — An alarm shall be included in the system to identify when pipeline water vapour exceeds dryness limits. This alarm shall be located in an appropriate place for timely intervention by regular maintenance staff. If regular maintenance staff are not directly responsible for medical air systems, the alarm shall be located in a suitable place with continuous responsible observation.

2.9.2.5 Air inlet and filtration

Air inlets and filters shall be provided as follows:

- (a) *Air inlet to compressors* — A separate air intake with an intake filter shall be provided as an integral part of each compressor. The filter element shall be suitable for the protection of the compressor under the local operating conditions likely to occur at the site of installation.
- (b) *Medical air filter* — Two filter sets shall be provided, each using an independent series of filter units. Each set shall be installed to enable maintenance or removal and replacement of any element without interruption of the medical air supply. Isolation valves shall be installed upstream of the inlet of the pre-filter and downstream of the outlet of the final filter. Valves and connecting pipework shall not be sized less than the port size of the respective filters.

Each filter set shall comprise three filter units installed in series. The units shall be a pre-filter, an activated carbon filter and a final filter. Each unit shall be fitted with an indicating differential pressure gauge, in-built automatic drains and pipe union fittings that will allow any filter unit to be removed from the set for maintenance.

Sizing of pre-filters, activated carbon filters and final filters shall be as follows:

- (i) *Pre-filter* — The pre-filter shall be sized to suit the system design flow rate with a maximum pressure loss of 7.5 kPa when the filter element is in a new condition. The filter element shall conform with ISO 8573-1, Class 2 with a maximum particulate retention rating of 1.0 µm.
- (ii) *Activated carbon filter* — The activated carbon filter shall be sized to suit the system design flow rate with a maximum pressure loss of 7.5 kPa when the filter element is in a new condition. The filter element shall conform with ISO 8573-1, Class 1, with a maximum particulate retention rating of 0.01 µm. The maximum oil carryover at 200 °C shall be no more than 0.003 ppm (0.003 mg/m³).
- (iii) *Final filter* — The final filter shall be sized to suit the system design flow rate with a maximum pressure loss of 10.0 kPa when the filter element is in a new condition. The filter element shall conform with ISO 8573-1, Class 1 with a maximum particulate retention rating of 0.01 µm.

NOTE ISO 8573-1 has been nominated because filters currently available are manufactured in Europe, and specifications and documentation provided by the suppliers only use ISO references.

2.9.2.6 Medical air pressure control

Duplicate pressure regulators, each sized for the full system requirement, shall be provided in the piping system upstream of the plant room distributor header.

Pressure regulators shall be arranged in parallel, complete with isolation valves and pressure relief valves, so that either are able to be isolated for maintenance without interruption to medical air supply.

2.9.2.7 Medical air compressor control

Controls shall be arranged so that compressors are able to supply the system in turn or simultaneously on demand. Controls shall be provided to activate any additional units automatically in the event that the lead unit of the system becomes incapable of maintaining adequate supply. Controls shall be arranged so that a failure of one compressor control system will not interfere with the correct operation of the remaining plant. Malfunction or incapacity to meet demand shall initiate an alarm.

Where medical air compressors are water cooled, the following additional controls shall be installed:

- (a) A flow switch on the incoming water line.
- (b) A solenoid valve connected to the start control of the particular machine, which shall open when the machine starts and close off cooling water when the machine stops.
- (c) Water and air thermostat.

NOTE 1 These measures are required to prevent condensation on cylinder walls, the machine running without water, water wastage condensation, and overheating.

Medical air compressors shall each be controlled by an independent pressure switch. This pressure switch shall have adjustable differential for cut-in and cut-out pressures or by continuous running of the lead compressor with unloading, with pressure switch control of lagging compressors. An automatic change-over switch for selection of the lead machine shall be provided for alteration of the duty machine after each cycle.

Change-over shall be automatic and independent of mains electrical supply. Facilities for manual change-over shall also be provided.

NOTE 2 Capacity flow of 100 % or greater during a single compressor failure may be achieved by compressors alone, or a combination of one or more compressors and manifolded cylinders. If the demand during a failure is met by compressors alone, it may be one compressor of 100 % capacity or two or more compressors of less than 100 % capacity. Three or more compressors usually allow for better matching of the demand, avoid the problems of short stop/start cycles and allow the use of simple low-cost motor starters.

2.9.2.8 Usage (hours run) meters

A usage meter shall be provided for each compressor so that compressor running hours are able to be balanced and maintenance programmed.

2.9.2.9 Medical air compressor protection

The following protection shall be provided for the compressor installation:

- (a) High rupturing capacity fuse protection on the power supply to each medical air compressor.
- (b) Thermal overload protection in each compressor starter.
- (c) Phase failure detection to allow full automatic shutdown if power fails on one or more phases of a multiphase power.
- (d) Flexible connections between plant and pipeline to prevent vibration damage.
- (e) Where appropriate, a low oil pressure cut-out with manual reset in the electrical control circuits of each compressor.
- (f) A discharge air high temperature cut-out with manual reset.

In addition, for further protection, the compressors or associated equipment should have sensing devices connected to any other parts or functions susceptible to breakdown, e.g. water flow sensing.

2.9.2.10 Siting of medical air compressor installations

Medical air compressor installations shall be situated in well-lit, well-ventilated rooms with the necessary drain facilities. The ambient temperature in the enclosure or rooms shall not exceed the manufacturer's specifications. Plant rooms shall be of adequate size to permit all maintenance procedures to be carried out in a simple and efficient manner. Flexible mounting shall be installed between the compressor and the floor.

NOTE It is recommended that plant rooms are air-conditioned or mechanically ventilated.

Compressor air intakes shall be situated to draw in air free from potential contamination, e.g. from car parks, discharge from incinerators or boiler stacks or contaminated air exhausts, and preferably with the intake filters located in a position to facilitate ease of maintenance and inspection.

2.9.3 Medical air cylinder supply system

Where used, cylinder supply systems shall be in accordance with [Clause 2.4](#).

2.9.4 Non-therapeutic use of medical air

If medical air is provided for non-therapeutic purposes, such as operation of ceiling articulated services modules, anaesthetic gas scavenging systems, medical air for medical personnel or testing or drying of medical devices, the flow requirements of these applications shall be taken into account by the designer of the system.

Flow shall be limited to less than 10 L/min and means provided to isolate the medical air supply in the event of failure.

Means shall be provided to prevent back flow into the pipeline.

Medical air shall not be provided for applications such as general workshop use, motor repair workshop use, spray painting, tyre inflation, reservoirs for pressurization of hydraulic fluids, or pneumatic control of air conditioning, which may impose unforeseen demands and could compromise the availability or quality of air for normal patient care purposes..

2.10 Medical suction systems

2.10.1 General

In the design of suction systems, the cost and construction penalty for oversizing the pipework is small. The same is not true of the sizing of the plant. Over-sizing of the plant has a major impact on both cost and construction. For this reason, separate design flow rates for pipelines and for plant calculations should be used.

NOTE [Appendix A](#) and in particular [Table A.4](#) give guidelines for estimating these flow rates.

A combination of pump suction and venturi ejector operated suction terminal units shall not be installed downstream of the same zone isolation valve box, or in the same area if a new zone isolation valve box is installed.

If a healthcare facility uses a combination of both pump suction and venturi ejector operated suction systems, consideration should be given to upgrading the entire facility to pump suction supply systems.

2.10.2 Pipeline suction system

2.10.2.1 Performance

The design of the pump suction system and capacity of the pumps shall be such that suction of at least -60 kPa with a free air-flow of not less than 40 L/min is achieved at any one suction terminal unit. [Figure L.12](#) shows an example of a source of supply for medical suction.

2.10.2.2 Size of suction piping

Size of piping to all areas shall be calculated from the design flow or minimum pipe size in accordance with [Clause 4.5](#), whichever is largest.

NOTE 1 Guidelines for design flow are given in [Table A.4](#).

NOTE 2 In special care locations, the pipework should be designed to reduce to a practical minimum any variation in pipeline suction between adjacent terminal units due to a variation in flow through one of the terminal units.

NOTE 3 Design flow is employed for the purpose of calculating requirements for pump and pipework design and is the sum of the maximum flow requirements estimated for each supply area.

NOTE 4 The number of suction terminal units referred to in [Table A.4](#) is the minimum. Medical staff should be consulted before finalizing the number and the position of all suction service points.

NOTE 5 Pipework and terminal units should be arranged in such a manner, e.g. in ducts, that the service is able to be expanded as required without major alterations to the building being necessary.

2.10.2.3 Suction pump source of supply

The following requirements and recommendations apply:

- (a) *Suction pumps* — A minimum of two suction pumps, preferably identical, shall be installed. Each pump shall be capable of supplying the design flow rate on its own. The electrical connection to each of multiple pumps in an installation shall ensure that failure of one suction pump does not interfere with the correct operation of the remaining pump (or pumps).

If more than two suction pumps are used as the source, the capacity of the pumps shall supply at least the designed flow rate for the system with any one pump out of operation, i.e. a source of N pumps shall meet or exceed the design capacity with (N-1) pumps operating.

Suction pump performance shall be specified in volumetric capacity and free air-flow.

Noise generated from the plant shall not cause sound pressure levels in adjacent areas to exceed the levels stated in AS/NZS 2107 for health buildings.

Vibration generated from the plant shall not exceed the levels specified in AS 2625.1 and AS 2625.4.

NOTE 1 An installation of more than two suction pumps may be preferred because of the large difference between maximum and minimum requirements.

Each suction pump shall display a safety label with the words “CAUTION: THIS MACHINE IS REMOTELY CONTROLLED AND STARTS WITHOUT WARNING”, or words to that effect.

- (b) *Electrical requirements* — The suction source shall be manufactured and installed in accordance with the electrical requirements of AS/NZS 3000 and connected to the essential services supply.
- (c) *Suction receiver* — The nominal volume of the receiver and pipework should be designed for not less than 50 % of the design flow rate (volume per minute) of the system (see [Table A.4](#)). The vessels should be suitable for the pressures and environmental conditions of the application.

NOTE 2 A smaller suction receiver may be suitable if a variable speed drive system is used.

- (d) *Pump inlet filters* — Pump inlet filters shall be installed to remove solids, particulate matter and free moisture to prevent damage to the suction pumps. A duplicated filter assembly complete with isolation valves and pressure differential gauge shall be provided in the pipeline, and arranged to enable maintenance or replacement of either filter assembly without interruption to the suction system.

The medical suction filter shall be a biological filter sized to suit the design flow rate with a maximum pressure loss of 3.5 kPa and the filter element is in a new condition. The filter element shall conform with ISO 8573-1, Class 1, with a particulate retention rating of 0.01 µm.

NOTE 3 Consultation with the healthcare facility’s accredited representative is desirable in regard to handling and disposal of the filter.

- (e) *Pump discharge* — The discharged gases shall be vented outside the pump house to atmosphere in accordance with AS 1668.2. The exhaust outlet should be covered with a non-corrosive grid or mesh to prevent the entry of insects/vermin. The exhaust outlet should also be protected from the ingress of water.

NOTE 4 Back pressure from the pump discharge should be taken into account when selecting pumps.

- (f) *Suction pump control* — Controls shall be arranged so that a failure of one pump control system will not interfere with the correct operation of the remaining plant.

Controls shall be provided to activate any additional suction pumps automatically if the lead unit of the system is incapable of maintaining adequate supply. Where there is malfunction or insufficient capacity to meet demands, alarms shall be initiated.

Where suction pumps are water cooled, the following additional controls shall be installed:

- (i) Flow switch on the incoming water line.
- (ii) Solenoid valve connected to the start control which opens when the machine starts and closes off cooling water when the machine stops.

For reasons of economy and safety, water-sealed pumps shall use water recirculation.

Suction pumps shall each be controlled by an independent pressure switch with adjustable differential for cut-in and cut-out pressures or by continual running of the lead suction pump, with pressure switch control of lagging suction pumps. An automatic change-over switch for

selection of the lead suction pump shall be provided for alteration of the duty suction pump after each cycle.

- (g) *Usage (hours run) meters* — A usage meter shall be provided for each pump so that running hours are able to be balanced and maintenance be programmed.
- (h) *Suction pump protection* — The following protection shall be provided for the installation:
 - (i) High rupturing capacity fuse protection on the power supply to each pump.
 - (ii) Thermal overload protection in each starter.
 - (iii) Flexible connections between plant and pipeline to prevent vibration and damage.
 - (iv) A cut-out switch with manual reset in the electrical control circuits of each pump, actuated either by a low oil level or a low oil pressure.
- (i) *Siting of suction pump installations* — Suction pump installations should be situated in well-lit, well-ventilated rooms with necessary drain facilities. Plant rooms should be of adequate size to permit all maintenance procedures to be carried out simply and efficiently.
- (j) *Vacuum gauge* — A vacuum gauge conforming with the requirements of AS 1349, calibrated from -100 kPa to 0 kPa and with a dial of not less than 100 mm diameter, shall be installed in the plant room in a clearly visible position to indicate available suction.
- (k) *Valve system* — Where three-phase electric motor-driven positive displacement pumps are used with the associated possibility of accidental reversal of direction of pump rotation, a valve system shall be installed between the pump and pipe reticulation system to prevent positive pressure developing in the system.

NOTE 5 In siting the pumps or pump house, due consideration should be given to the need to avoid any possibility of contamination of other systems by oil or oil mist where this could be hazardous (e.g. explosion with stored oxygen) and the possibility of nuisance arising from undue noise and vibration transmitted to other parts of the building.

NOTE 6 It is strongly recommended that suitable means be provided for silencing of exhausts from pumps.

NOTE 7 Some suction pumps may incorporate a non-return valve system in their inlet housing.

2.10.2.4 Suction systems to special care locations

Provision shall be made for suction to be maintained to special care locations. Suction pump motors, alarms and switchgear should be connected to essential electric power as a safeguard in the event of mains failure.

Where no essential electric power connection is available, alternative suction shall be provided by other means which meet the performance requirements of [Clause 2.10.2.1](#), e.g. suction powered by compressed gas (oxygen or medical air).

2.10.3 Compressed gas venturi ejector-operated suction system

2.10.3.1 Performance

The design of the compressed gas supply system shall ensure that performance of the venturi ejector operated system is maintained under design flow conditions.

NOTE 1 A compressed gas venturi ejector operated suction system is an alternative system to suction pipeline systems. A venturi ejector operated system is commonly powered from the medical air system. In calculating the medical air requirements of a MGPS, the supply capacity of the venturi ejector operated system and that of the medical air system should be added.

NOTE 2 [Table A.4](#) gives guidelines to help determine the design flow for pipelines and for plant systems.

The design of the venturi ejector shall achieve a free air-flow of not less than 40 L/min and an occluded suction of at least -60 kPa.

NOTE 3 Efficient use of driving gas in an ejector is important. To conserve driving gas, ejectors should have a driving to entrainment gas flow ratio of no more than 110 %.

2.10.3.2 Compressors

Where dedicated compressors systems are used for venturi ejector operated suction systems they shall conform with the requirements of [Section 2](#) except that the air compressors need not supply air of medical air quality. Piping shall be labelled as "Air for driving venturi suction only".

NOTE If a medical air supply is available in the building, that supply should be used to power the venturi ejector operated system. If a separate air supply is from a compressor which may be contaminated with water, oil or carbon monoxide is used, a misconnection or cross-connection may remain undetected as the usual tests of gas composition will not distinguish the two pipelines. However, the use of this air for patient treatment may damage ventilators or other respiratory equipment, and may also harm patients.

2.10.4 Anaesthetic gas scavenging systems

2.10.4.1 General

Scavenging systems for anaesthetic gases should be coupled to pump suction or venturi ejector operated suction systems. Scavenge and suction should have the same source of supply.

In addition to a suction terminal unit, a terminal unit available for scavenging shall be installed at every location where nitrous oxide or inhaled anaesthesia or their mixtures are likely to be used.

Exhaust locations should permit vented gases to escape passively and not be retained in an enclosed space.

2.10.4.2 Diversity factor

The diversity factor for terminal units for scavenging systems shall be in accordance with [Table A.3](#).

2.11 Surgical tool air systems

2.11.1 General

The source of supply system for surgical tool air may comprise a cylinder supply system as specified in [Clause 2.4](#), or a compressor system (see [Figure L.11](#)).

Supply pressure shall be according to [Clause 3.4.2](#) and [Table 3.1](#). A diversity factor of not less than 0.2 shall be applied to the pipeline design.

The source of supply for surgical tool air shall be independent of the source of supply for medical air.

Surgical tool air shall not be provided for applications such as general workshop use, motor repair workshop use, spray painting, tyre inflation, and reservoirs for pressurization of hydraulic fluids, or pneumatic control of air conditioning, which may impose unforeseen demands and potentially compromise the availability or quality of air for patient care purposes.

Where surgical tool air is provided for other purposes, such as operation of articulated services modules, anaesthetic gas scavenging systems, or testing or drying of medical devices, the flow requirements of these applications shall be taken into account by the manufacturer of the system.

NOTE 1 A reserve supply for surgical tool air should be provided if the healthcare facility deems it necessary.

NOTE 2 An oil-lubricated compressor with filtration may be used for surgical tool air.

2.11.2 Air purity and dryness

When measured at normal temperature and pressure, the air supplied shall have a level of purity that meets the following requirements:

- (a) *Oxygen* — The range for oxygen shall be between 19 % v/v and 23 % v/v.
- (b) *Water Vapour* — Surgical tool air shall be dried to a moisture content of not greater than 60 ppm.
- (c) *Oil* — Surgical tool air shall be filtered to an oil level not greater than 0.1 mg/m³.

NOTE 1 For further information on the relationship between temperature and pressure see [Appendix I, Figure I.1](#).

NOTE 2 This level of dryness cannot be achieved by conventional refrigeration drying.

NOTE 3 Medical air from cylinders achieves a dryness appropriate for driving surgical tools. Compressor systems can achieve a sufficient level of dryness for driving surgical tools if chemical drying is used in series with refrigeration drying. However, regular maintenance and monitoring of compressor systems is essential, and such systems may be more expensive overall than cylinders.

2.12 Locations of source of gas supply

2.12.1 Security

Cryogenic liquid systems, medical air plant or suction plant rooms and cylinder storage and manifold areas shall be protected from vehicular traffic damage and secured against unauthorized access, tampering, sabotage, vandalism or theft.

2.12.2 Cryogenic liquid systems

The location of cryogenic liquid systems shall conform with the requirements of AS 1894. Stationary cryogenic liquid oxygen vessels shall be installed in a position which is well ventilated, with the control equipment protected from the direct impacts of weather and within a fenced area to prevent unauthorized access. When a cryogenic liquid supply plant is to be filled from road tankers, adequate access for the vehicles shall be provided. The vehicle standing and discharge area shall be constructed in accordance with the requirements of AS 1894.

All parts of the area of the depot on which any liquid oxygen is likely to spill shall be paved with smooth, trowelled concrete of a designed strength to withstand any traffic load.

Service facility inlets of cryogenic liquid systems shall be located so there is easy access for connection of cylinders, packs of cylinders or mobile cryogenic liquid supply. Where buried, concealed or covered pipelines are used from the primary source of supply, the service facility inlet shall be on the healthcare facility side of the buried, concealed or covered pipeline.

Cryogenic liquid pipelines shall be sited in accordance with the instructions of the gas supply contractor. Cryogenic liquid pipelines should not be buried or reticulated under roadways.

NOTE 1 Healthcare facilities should take steps to prevent casual vehicular parking on the concrete area. Oil leaks from parked vehicles may contaminate the concrete and cause a fire if an oxygen spill occurs.

NOTE 2 Ideal access is drive in and drive out, which minimizes the risk of reversing a road tanker, and the associated hazards to others in the area and potential damage to the cryogenic vessel. The gas supply company should be contacted for extra advice on the design and layout of bulk cryogenic sites.

2.12.3 Gas manifold system

2.12.3.1 General

Gas manifold systems shall be installed only in ventilated areas, as specified in AS 4332, thus ensuring that the risk of oxygen enrichment or deficiency in parts of the building is minimized, and that risks are minimized for operators in the operation of the system.

Except for robust hardwood timbers treated with fire inhibitors, combustible materials, including gases or liquids, shall not be permitted within the area. Such timbers may be used as rubbing strips on the walls and floor to assist in reducing noise and percussion sparking.

Sources of supply of oxidising gases shall not be placed in the same area as oil lubricated plant.

2.12.4 Electrical fittings

All electrical fittings, including lighting in supply rooms, shall be installed to avoid physical damage from cylinder handling.

2.12.5 Ambient temperature

Ambient temperature in enclosures or rooms for supply systems shall not exceed 55 °C for any gas and be no less than 0 °C for nitrous oxide/oxygen mixture (50/50 nominal). Heating techniques shall be of a flameproof type.

2.13 Enclosures for cylinder supply systems

2.13.1 Cylinder storage

Cylinders shall be stored in accordance with AS 4332. As a minimum spare cylinders with capacity equivalent of 50 % of the connected supply shall be stored on-site, available to replace the depleted cylinders. Storage and use of gases, especially inert gases, requires as much ventilation as practically possible, preferably by outdoor siting, but no less than what is required by AS 4332. Cylinder storage areas shall be protected to prevent unauthorized access in accordance with [Clause 2.12](#).

Industrial grades of gas and gas mixtures and medical grades of gas and gas mixtures shall be easily identified and stored in separate areas. Flammable gases or substances shall not be kept in the same area as oxidising gases in either gaseous or liquid form.

NOTE: Oxidising gases include nitrous oxide and those containing oxygen content of ≥ 25 %.

Provision should be made for the use of cylinders in the order of their receipt and for separate grouping and marking of empty cylinders.

Storage rooms with one or more sides longer than 5 m should have an alternative exit door which can be opened from the inside in an emergency.

2.13.2 Interior and exterior enclosures

Enclosures (interior or exterior) for supply systems shall conform with AS 4332 as follows:

- (a) Allowing adequate separate space for storage of full and empty cylinders.
- (b) Being of adequate size to contain the total supply system and to permit operational and maintenance procedures to be carried out safely.
- (c) Not being located close to exposed electrical conductors, transformers or a source of electrical arcing.

- (d) Not being located close to oil storage tanks.
- (e) Being of a construction to prevent cylinder temperatures exceeding 55 °C when located near sources of heat such as furnaces, incinerators or boiler rooms.(f) Having a trowelled concrete floor of sufficient strength to withstand the imposed load

2.13.3 Specific requirements of interior enclosures

When manifolds are to be installed indoors, they shall be in a dedicated area constructed of impervious non-combustible materials in accordance with AS 4332.

NOTE 1 Where the use of cylinder packs is anticipated, provision should be made for larger doorway access.

NOTE 2 If an indoor space is not naturally ventilated (refer to AS 5034), consideration should be given to installation of oxygen depletion monitors if asphyxiant gases are used, and oxygen enrichment monitors if oxygen is used.

2.13.4 Specific requirements of exterior enclosures

When manifolds are to be installed outdoors, the enclosure shall have a minimum height of 2.2 m and be separated from other areas by lateral and vertical separation in accordance with AS 4332.

The equipment and control panel shall be protected from the weather.

The equipment and control panel should be of weather-proof construction.

Cylinders should be protected from direct sunlight.

2.13.5 Signs

Prominent signs conforming with AS 1319 shall be displayed in storage and manifold areas.

Signs shall display the following information or warnings, as applicable:

- (a) Danger — Compressed gases.
- (b) Danger — Oxidizing gases.
- (c) Danger — Asphyxiant gases/Gases with asphyxiation hazard.
- (d) No smoking or naked lights.
- (e) No entry — Authorized persons only.
- (f) No oil or grease.
- (g) No combustible material to be placed within 5 m.
- (h) The maximum working pressure of the gas control system.

A suitable notice shall list the main safety instructions, including a list of emergency procedures (e.g. use of emergency isolation valves, location of firefighting equipment).

A weather-resistant sign shall be erected outside the storage and manifold areas showing telephone numbers of the following:

- (i) Fire Brigade.
- (ii) Gas supplier (normal and after hours).
- (iii) Police.
- (iv) Appropriate healthcare facility personnel (e.g. hospital engineer, safety officer)

2.13.6 Delivery access and docks

The area should be easily accessible to delivery vehicles. Cylinder docks should be at vehicle tray height (usually 1 m). The area between the cylinder docks and the respective manifold room shall allow the free and easy passage of a manually operated cylinder trolley.

Section 3 General requirements

3.1 Locations

3.1.1 Anaesthetizing locations

Essential features of anaesthetizing locations include the delivery of nitrous oxide, inhaled anaesthetic agents or their mixtures via conduit directly to the patient's airway, and requirements for —

- (a) local alarms to alert the operator directly in the event of pipeline supply problems (see [Clause 3.2](#));
- (b) scavenging and suction (see [Clause 2.10.4.1](#)); and
- (c) valve boxes (see [Clause 3.5](#))

Generally anaesthetizing locations are locations where nitrous oxide is piped. Examples of these locations include operating rooms, interventional cardiology, brachytherapy, radiotherapy, endoscopy, birthing areas, treatment and procedure rooms, including those in the emergency department and diagnostic imaging suites, including but not limited to suites for MRI, PET and CT.

NOTE: Clinicians from the anaesthetic department and relevant specialities managing procedural areas within the healthcare facility may advise variation of medical gas requirements for piping to the area to not include the above areas or to include additional areas as required.

3.2 Alarm systems

3.2.1 General

The supply status of medical gases is required to be monitored by an alarm system.

The signal and communication cabling associated with the alarm system shall be extra low voltage.

The purpose of the alarm is to notify of actions which need to be taken to maintain the gas supplies and to alert of imminent gas failure. These alarms would include signals such as “Order oxygen”, “Renew cylinders”, oxygen fail and alarm malfunction.

The alarm panel shall indicate the status of the MGPS as follows:

- (a) *All systems normal* — Indicates that all medical gas supplies are operating within designed limits and that the alarm system itself is operating normally.

A message “All medical gases normal” shall be displayed. The message shall be a green colour (background or text coloured) or a message with an adjacent steady-state green coloured indicator.
- (b) *All systems normal but an additional action is required to ensure continued supply* — Indicates that one or more gas supplies have reached a point where operator action is required e.g. re-ordering or replacement of gas cylinders. This alarm status is indicated by an appropriate message indicating gas specific action is required, e.g. “Renew oxygen”. The message shall be a steady or flashing amber colour (background or text coloured) or a message with an adjacent steady or flashing amber coloured indicator in accordance with [Appendix B](#). An audible alarm shall be activated.
- (c) *Emergency condition:*
 - (i) *Emergency supply* — Indicates that emergency supplies are in operation and total failure will occur without urgent action. This alarm status is indicated by an appropriate message indicating emergency supply is in operation e.g. “On oxygen backup supply”. The message shall be a steady red colour (background or text

coloured) or a message with an adjacent steady red coloured indicator in accordance with [Appendix B](#). An audible alarm shall be activated.

- (ii) *Supply failure* — Indicates a high priority alarm condition which requires immediate action. This alarm status is indicated by an appropriate message indicating supply gas failure (e.g. “Oxygen supply failure”). The message shall be a flashing red colour (background or text coloured) or a message with an adjacent flashing red coloured indicator. An audible alarm shall be activated.
- (iii) Where continuous monitoring of gas constituents in the medical air or surgical tool air compressor systems is in place:
 - (A) *High contaminant level* — Indicates that the nominated medical or surgical tool air contaminant is at an elevated level and may continue to increase to a point exceeding the tolerance level without intervening action. It is indicated by a message signalling the high contaminated level, e.g. “High carbon monoxide level”. The message shall be a steady red colour (background or text coloured) or a message with an adjacent steady red coloured indicator. An audible alarm shall be activated.
 - (B) *Critical contaminant level* — Indicates a high priority alarm condition which requires immediate action. This alarm status is indicated by an appropriate message signalling critical contaminant level e.g. “Critical carbon monoxide level”. The message shall be a flashing red colour (background or text coloured) or a message with an adjacent flashing red coloured indicator. An audible alarm shall be activated.
- (d) *Diagnostic condition signal* — Indicates a malfunction in the alarm system. The message shall be flashing amber (background or text coloured) or a message with an adjacent flashing amber indicator. An audible alarm shall be activated.

NOTE Alternative means should be put in place to monitor the status of the MGPS either locally or globally until the alarm system has been repaired.

Each of the categories (a) to (d) shall have visual and audible characteristics easily distinguishable from their surroundings and conform with [Appendix B](#).

For categories (b) to (d), a steady amber, flashing amber, steady red or flashing red indicator shall cancel a green indicator. A steady red or flashing red indicator shall cancel a steady or flashing amber indicator. A flashing red indicator shall cancel a steady red indicator.

The level of alarm condition indications from lowest level to highest level is; green, steady amber, flashing amber, steady red and flashing red. The alarm colour indication, alarm panel location and maximum alarm mute times listed in [Appendix B](#) are the minimum requirements in the Standard. If agreed between the healthcare facility operator, contractor and installer:

- (A) A higher level alarm indication may be used.
- (B) The alarm signal may be displayed on more alarm panels.
- (C) The maximum alarm mute time may be reduced.

Muting an alarm on one panel or system device shall not mute any other panels in the system.

The alarm system shall recognize and alert an open or short circuit in the cabling between the sensor and indicator panel. A message “Open or short circuit” shall be displayed.

A means shall be provided for testing the operation of the alarm signal source without affecting the operation of the MGPS, e.g. pressure switches.

In all anaesthetizing locations, oxygen supply shall be fully protected to the extent of local failure warning and installation of a reserve cylinder on each anaesthetic machine (see also [Clause 2.3.1](#)).

NOTE 1 Integration of alarm systems with a supply to each patient care area should aim to achieve a reasonable time for action to ensure continuous supply of essential gases to patients. Requirements for each area should be examined to determine how an appropriate warning of gas failure may be given, and what level of protection against failure is required.

NOTE 2 Generally, anaesthetic practice dictates that nitrous oxide and medical air also require close protection. Other areas may need similar arrangements if patients are critically supported by one or more gas services (see also [Clause 2.3.1](#)).

NOTE 3 If an alternative source of oxygen supply is immediately available in the area (and the patient is under continuous observation), only a local warning of failure is required. If a source of supply is not immediately available but can be obtained within a reasonable period [usually half of the emergency supply duration (see [Clause 2.3.1](#))], a local warning of activation of the emergency supply should be provided in the location.

NOTE 4 Although many wards and special care locations do not require close monitoring of gas supply, in some circumstances this may be necessary. However, special situations may require a more extensive approach for some locations in the healthcare facility, e.g. units which routinely undertake ventilation support should have an emergency supply warning although emergency supply warning is not generally required for coronary care units.

3.2.2 Installation requirements

Installation of alarm systems shall conform with the following requirements:

- (a) Indicator panels for alarms shall be sited to ensure continuous responsible observation. Such alarms shall be located as follows:
 - (i) In all anaesthetizing areas and operating rooms. This includes locations where anaesthesia is identified as being required outside the operating room and should be confirmed with the relevant clinical specialist prior to installation. Common locations include interventional cardiology, brachytherapy, radiotherapy, endoscopy, and diagnostics imaging suites (e.g. MRI, PET scans, CT scan).
 - (ii) In special care location units.
 - (iii) In coronary care units.
 - (iv) In recovery areas.
 - (v) A birthing area consisting of one or more delivery rooms shall have gas failure alarms in each delivery room.
 - (vi) At nurse's stations or other suitable locations near the point of use (see also [Appendix B](#)).

NOTE 1 Continuous observation is deemed to be observation for the duration of use of the gases from the MGPS.

NOTE 2 It is recommended that gas failure alarms be installed in locations where they are visible to the attending healthcare practitioners in areas where nitrous oxide is used.

NOTE 3: For anaesthetic induction rooms adjacent to operating rooms, the alarm in the operating room is sufficient, provided that the alarm is audible in the anaesthetic induction room. . An anaesthetic induction room separated from the operating room by a corridor is not considered adjacent to the operating room.

- (b) The alarm system shall be networked using one of the following:
 - (i) A proprietary network with an interface module which allows it to communicate to other systems.

- (ii) The healthcare facility data network using standard IP protocols.
- (iii) A wireless network which employs data security.
- (iv) The healthcare facility Building Management system (BMS) network.

All network infrastructure shall be connected to UPS or essential power supply. In addition to this, a failure of the above networking systems shall not render any alarm panel inoperative. The failure of any alarm panel on the network shall result in an alarm being generated indicating which alarm panel has failed.

NOTE 3 Signals from an existing network may be used to interface the medical gas alarm system.

- (c) Electricity supply to power the alarm system shall be one or more of the following:
 - (i) UPS or Essential power.
 - (ii) Direct current from a battery charger system with suitable means to prevent accidental switching off or disconnection. The system shall be connected to an essential or UPS power.
 - (iii) Power over Ethernet (POE) from data network (where the switches are connected to essential or UPS power).
- It shall not be possible to turn off the alarm with a readily accessible local switch.
- (d) A pressure sensing device for supply fail alarms shall be located adjacent to and downstream to every zone isolation valve box. Provision for testing these alarms without interfering with gas supply shall be provided.

3.2.3 Indicator panels

Indicator panels shall include the following:

- (a) A coloured alphanumeric display or a monochrome alpha numeric display with coloured indicators. The display messages shall be readable from at least 1 m, and be clearly visible under all background lighting conditions, including no light.
- (b) Test functions to confirm which alarms are being monitored and to test the operation of the display, indicators and audible alarm signals.
- (c) If the audibility of the alarm is adjustable, the set points shall be indicated continuously or on operator demand. At the minimum setting, the volume should be discernible to a person with normal hearing, above a background white noise level of 55 dB(A) at a distance of 3 m from the alarm panel.
- (d) The maximum alarm mute time shall be as [Clause 3.2.1](#) and [Appendix B](#). Each new alarm signal shall initiate the audible feature regardless of the status of the muted device.
- (e) Visible indication of status and audible signals for low pressure and failure for the MGPS. Audible sound and status indication for the area shall also be installed in each designated special care location (see also [Clause 3.2.4.4](#)).
- (f) Indication of normal conditions and “Power on”, with green colour indicator and appropriate text message, e.g. “All medical supplies normal”.
- (g) If the alarm network is interrupted, an alarm message “Loss of network connection” shall be displayed. All network connections are to be at $\leq$ ELV.
- (h) A diagnostic watchdog to ensure that the alarm is operating correctly. A message “System failure” or specific indicator shall illuminate when this fault occurs.

A means of muting the alarm should be provided.

Incandescent lamps, if used, shall be duplicated. They should be under-run to 80 % of the lamp voltage. Under-running shall not prevent the visual signal being clearly visible under all lighting conditions.

3.2.4 Operating alarm systems

3.2.4.1 Secondary supply alarm

An alarm system shall be provided for each medical gas to indicate by visible and audible signals that change-over to secondary supply is occurring or is about to occur. The visible signal in this system shall be as described in [Clause 3.2.1](#) (b) and [Appendix B](#).

The alarm pressure switch should be set to initiate the alarm at the failure of operation of the lead compressor or suction pump.

Where two or more medical air compressors or medical suction pumps are installed, an alarm which is initiated when the last compressor or suction pump comes into operation shall be provided. The alarm shall continue to display a visual indication until the situation is manually corrected.

3.2.4.2 Emergency supply alarm activation

An emergency supply alarm for oxygen and medical air shall be provided to indicate by visible and audible means that the emergency system is the source of supply and that the supply system is about to fail. This alarm may also be activated for suction and for medical air if the compressors are not started by the normal fall in supply pressure.

For medical air and venturi ejector operated suction, the alarm shall be activated by low pipeline pressure. For medical suction, the alarm shall be activated by a low suction level in the pipeline.

The emergency supply alarm shall be installed in all special care locations.

Where interruption of supply may present an unacceptable hazard to patients or staff, an emergency supply failure alarm system shall be provided for surgical tool air, nitrous oxide and medical carbon dioxide.

3.2.4.3 Pressure settings for supply failure alarm

For all medical gases the alarm shall operate when the line pressure falls to 20 % below the nominal working pressure (see [Figure 2.3](#)). For suction, the alarm shall operate when the suction pressure falls to 20 % less than the nominal working pressure.

NOTE A suction pressure is said to be falling when it is moving towards atmospheric pressure, e.g. changing from -80 kPa gauge pressure to -73 kPa gauge pressure.

3.2.4.4 Local failure alarm

To facilitate surveillance of the medical gas supply, a separate visible and audible signal, activated by the pressure in the line being monitored as in [Clause 3.2.4.3](#), shall be provided in all special care locations. An indicating pressure gauge shall also be provided for each supply. The alarm signals shall be located at the nurse's station or other suitable location to facilitate immediate recognition.

For anaesthetic induction rooms adjacent to operating rooms, the alarm in the operating room is sufficient, provided that the alarm is clearly audible in the anaesthetic induction room. Every operating room shall have alarm signals located in the operating room, sited so that the visible alarm can be easily seen from the centre of the operating room or the usual site of the anaesthetic machine if all the walls of the operating room are not visible from a central position. Location of sensors shall be downstream of all the final isolation valves, but this requirement shall not apply to fixed secondary equipment, e.g. pendants, see [Clause 4.14.3](#).

3.2.4.5 Alarm instructions

Alarms for systems and areas shall have instructions prominently displayed next to them, detailing the action required in the event of an alarm condition.

NOTE Healthcare facilities should institute a written procedure to be followed in the event of an alarm activating.

3.2.4.6 Single area supply

Where a single patient care area only is supplied from the source, the local alarm and supply failure alarm (see [Clause 3.2.4.2](#)) may be the same alarm unit. However, this alarm unit shall be located in the single patient care area.

3.3 Materials

3.3.1 General

Copper tubes used for positive pressure and suction pipelines, shall be of as-drawn seamless tube, manufactured in accordance with AS/NZS 1571, with dimensions not less than that specified in AS 1432 for Type B tube.

Pipelines shall not be constructed from rigid PVC or other rigid thermoplastics as this may result in cracks and/or leakages as the materials degrade with age.

NOTE Plastic connections for gas tubing may be used for venturi ejector operated suction exhaust as the terminal units are under positive pressure.

3.3.2 Oxygen compatibility of components

All components of a pipeline system for all medical gases and suction shall be compatible with oxygen at the maximum pressures and temperatures of the system to which they are installed. They shall be proven suitable for oxygen use and supplied from the manufacturer, cleaned and sealed.

NOTE 1 [Appendix C](#) gives recommendations for the use of materials in the piping for the system.

NOTE 2 Compatibility involves both combustibility and ease of ignition. Materials which burn in air will burn violently in oxygen enriched environments. Also, many materials which do not burn in air will do so in pure oxygen, particularly oxygen under pressure. Similarly, materials which can be ignited in air have lower ignition energies in oxygen. Many such materials may be ignited by friction at a valve seat or stem packing or by adiabatic compression produced when oxygen at high pressure is rapidly introduced into a system initially at low pressure. The requirement of this Clause includes components for gases other than oxygen or oxygen mixtures because it is difficult to segregate materials in stores and particularly on construction sites during installation.

NOTE 3 ISO 15001 gives guidance on oxygen compatibility.

3.3.3 Cleaning of pipelines and components

3.3.3.1 General

As all pipes supplied in accordance with AS/NZS 1571 are factory cleaned, degreased and capped prior to delivery, the pipes shall not be cleaned on site, except for necessary purging operations to remove any particles entrained during installation.

All valves supplied shall have labels attached to the packaging, stating "Cleaned for oxygen service".

Particular care shall be exercised in the storage and handling of all pipe fittings. After cutting, pipes shall be temporarily capped or plugged to prevent contamination before final assembly. Fittings and valves shall be stored in new sealed plastic bags until installed. Tools used in cutting or reaming shall be kept free from oil or grease.