

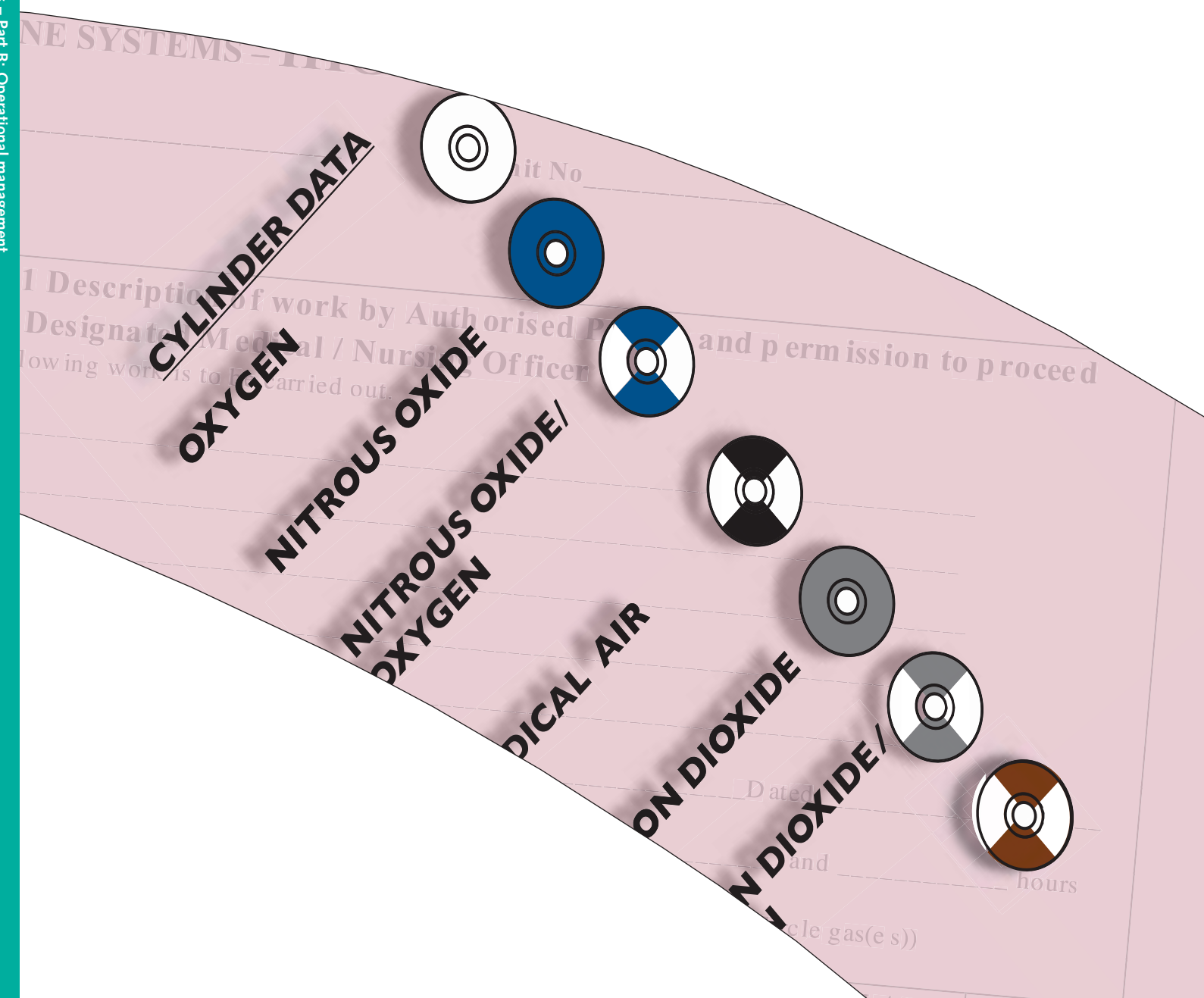
Medical gases

Health Technical Memorandum

02-01: Medical gas pipeline systems

Part B: Operational management

Medical gases – Health Technical Memorandum 02-01 Medical gas pipeline systems – Part B: Operational management



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Medical gases

Health Technical Memorandum

02-01 Medical gas pipeline systems

Part B: Operational management

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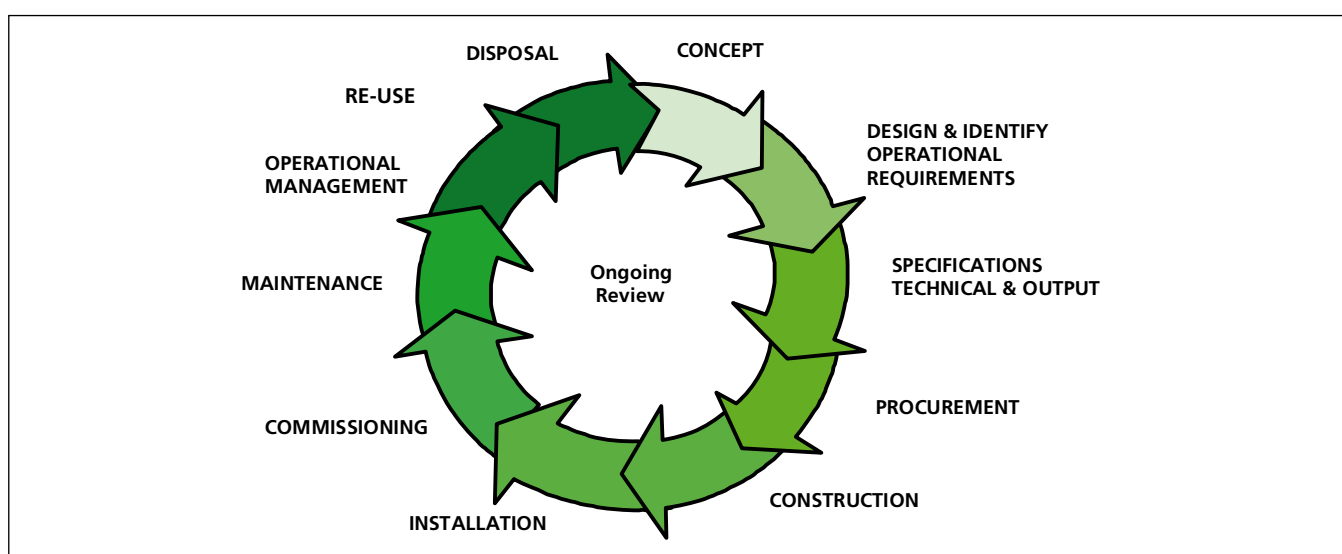
Preface

About Health Technical Memoranda

Engineering Health Technical Memoranda (HTMs) give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare.

The focus of HTM guidance remains on healthcare-specific elements of standards, policies and up-to-date established best practice. They are applicable to new and existing sites, and are for use at various stages during the whole building lifecycle:

Figure 1 Healthcare building life-cycle



Healthcare providers have a duty of care to ensure that appropriate engineering governance arrangements are in place and are managed effectively. The Engineering Health Technical Memorandum series provides best practice engineering standards and policy to enable management of this duty of care.

It is not the intention within this suite of documents to unnecessarily repeat international or European standards, industry standards or UK Government legislation. Where appropriate, these will be referenced.

Healthcare-specific technical engineering guidance is a vital tool in the safe and efficient operation of healthcare facilities. Health Technical Memorandum guidance is the

main source of specific healthcare-related guidance for estates and facilities professionals.

The new core suite of nine subject areas provides access to guidance which:

- is more streamlined and accessible;
- encapsulates the latest standards and best practice in healthcare engineering;
- provides a structured reference for healthcare engineering.

Structure of the Health Technical Memorandum suite

The new series of engineering-specific guidance contains a suite of nine core subjects:

Health Technical Memorandum 00

Policies and principles (applicable to all Health Technical Memoranda in this series)

Health Technical Memorandum 01

Disinfection and sterilization

Health Technical Memorandum 02

Medical gases

Health Technical Memorandum 03
Ventilation systems

Health Technical Memorandum 04
Water systems

Health Technical Memorandum 05
Fire safety

Health Technical Memorandum 06
Electrical services

Health Technical Memorandum 07
Environment and sustainability

Health Technical Memorandum 08
Specialist services

Some subject areas may be further developed into topics shown as -01, -02 etc and further referenced into Parts A, B etc.

Example: Health Technical Memorandum 06-02 Part A will represent:

Electrical Services – Safety – Low Voltage

Figure 2 Engineering guidance



In a similar way Health Technical Memorandum 07-02 will simply represent:

Environment and Sustainability – EnCO₂de.

All Health Technical Memoranda are supported by the initial document Health Technical Memorandum 00 which embraces the management and operational policies from previous documents and explores risk management issues.

Some variation in style and structure is reflected by the topic and approach of the different review working groups.

DH Estates and Facilities Division wishes to acknowledge the contribution made by professional bodies, engineering consultants, healthcare specialists and NHS staff who have contributed to the review.

Executive summary

Introduction

A medical gas pipeline system (MGPS) is installed to provide a safe, convenient and cost-effective system for the provision of medical gases to the clinical and nursing staff at the point of use. It reduces the problems associated with the use of gas cylinders such as safety, portering, storage and noise.

This Health Technical Memorandum is divided into two parts. Guidance in Part A deals with the design, installation, and validation and verification (testing and commissioning) of an MGPS. This part (Part B) covers operational management.

Health Technical Memorandum 02-01 supersedes all previous versions of Health Technical Memorandum 2022.

Operational management

The safe operation of a medical gas pipeline system relies on skilled staff who understand the system and who can liaise with clinical users to ensure continuing patient safety.

The pipeline systems contain gas under pressure, which can present a hazard to staff. The key to safe operational management is the availability of comprehensive installation data and maintenance manuals.

In addition, to ensure continued patient safety, permit-to-work procedures are essential to manage any intended or possible interruption of a supply.

Users of medical gas pipeline systems similarly need to be aware of the nature of the systems in order to understand the purpose of warning and alarm systems, and to participate in the safe operation of the systems. They should be familiar with the systems and be able to isolate them in the event of an emergency such as damage to terminal units within the clinical space, or in the event of a fire. A comprehensive operational policy that covers these various aspects is essential.

Portering staff responsible for the safe handling and use of medical gas cylinders should receive specific training before being permitted to change cylinders on manifolds or change cylinder regulators. This document should list key personnel involved in the operation, maintenance and use of the system. This will include nominated medical and nursing staff, risk managers/fire safety officers, pharmacy staff and the quality controller for the site, and competent personnel (who may be in-house staff or contractors). The document should list relevant drawings and include schedules of plant, terminal units, area valve service units (AVSUs), alarms, etc.

The Authorised Person (MGPS) has a pivotal role in the preparation of the necessary documentation, for example operational policy and its review and management thereafter, operating the permit-to-work procedure, and in advising users about the systems, and in the need for training of portering staff.

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Mike Arrowsmith Arrowsmith and Associates

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1 Scope

NOTE: Throughout this document, the phrase “Part A” is used as a generic term to describe the “Design, installation, validation and verification” part of Health Technical Memorandum 02-01.

General

- 1.1 This Part (Part B) of Health Technical Memorandum 02-01 covers the operational management and maintenance of systems for the supply by pipeline of:
- medical oxygen;
 - nitrous oxide;
 - nitrous oxide/oxygen mixture (50% v/v);
 - medical air for respiratory applications (at 400 kPa) and surgical air for tools (at 700 kPa);
 - medical vacuum;
 - helium/oxygen (oxygen 21%).

Waste anaesthetic gas scavenging systems (AGSS) are also covered.

Notes

Pipeline installations for carbon dioxide can be used for surgical purposes (see Chapter 11, Part A).

- 1.2 Throughout this document, the “medical gas pipeline system(s)” will be described by the term MGPS.
- 1.3 This guidance applies to all MGPS installed in healthcare premises.
- 1.4 An MGPS is intended to be a safe, convenient and cost-effective alternative to the use of “portable” cylinders, portable compressors and portable suction units, providing gas or vacuum for clinical needs without the associated problems of portage, noise and space wastage.
- 1.5 The guidance given in this Part should be followed for all new installations, and for refurbishment or upgrading of existing installations.

- 1.6 It is not necessary to apply the guidance retrospectively unless patient or staff safety would be compromised. In this case, the guidance given in Part A should be followed.
- 1.7 Existing installations should be assessed for compliance with Part A. A plan for upgrading the existing system should be prepared, taking account of the priority for patient safety. Managers will need to liaise with clinical staff and take account of the latest guidance published by the Department of Health in order to assess the system for technical deficiencies.
- 1.8 Part A also contains details of the design, equipment and operational parameters of systems that form the basis for Model Engineering Specification C11 – ‘Medical gases’. This specification is intended for the procurement of an MGPS. As technology develops, this Health Technical Memorandum and Model Engineering Specification C11 will be revised from time to time, but not necessarily simultaneously. Whichever document is the most current takes precedence.
- 1.9 Whenever appropriate, European/British Standards specifications should be used.

Operational management

- 1.10 Part B on operational management covers such issues as statutory requirements, functional responsibilities, operational policies, operational procedures, training and communications, cylinder management, general safety, maintenance and risk assessment, and control of exposure to anaesthetic agents, giving definitions and working practices throughout.
- 1.11 It is intended to be used by operational managers, engineers, quality controllers (QCs), technicians, finance officers and other professionals involved in the day-to-day running of an MGPS.
- 1.12 The primary objective of this Part is to ensure the provision of safe and reliable MGPS, and their

efficient operation and use. This objective will only be achieved if the medical and nursing users and estates staff participate in the introduction of an operational policy designed to minimise the hazards likely to arise from misuse of the system.

Other guidance

- 1.13** Guidance on provision of MGPS is also given in Health Building Notes.

2 Basic description of an MGPS

2.1 An MPGS comprises a source of supply, pipeline distribution system, terminal units (to which the user connects and disconnects medical equipment) and a warning/alarm system.

2.2 Systems are provided for:

- oxygen (O_2);
- nitrous oxide (N_2O);
- nitrous oxide/oxygen mixture (N_2O/O_2 : 50%/50%);
- medical air (MA4) at 400 kPa for respiratory applications, and at 700 kPa (SA7) for surgical tool applications;
- helium/oxygen mixture (He/O_2 : $He = 79\%$; $O_2 = 21\%$); and
- medical vacuum at a pressure of 400 mm Hg (53 kPa) below atmospheric pressure.

An AGSS is also provided where nitrous oxide is used for anaesthetic purposes (anaesthetic gas scavenging can be carried out in dentistry where a nasal mask is used for relative analgesia).

Notes

Pipeline installations for carbon dioxide can be used for surgical purposes (see Chapter 11, Part A).

2.3 Various medical gas systems and pipeline installation elements are shown in Part A.

2.4 Details of the quality requirements for medical gases are given in Chapter 15, Part A. These requirements are summarised as follows:

- a. medical gases supplied from cylinder or liquid sources should comply with the appropriate European Pharmacopoeia (Ph. Eur.) monograph;
- b. medical air and pressure swing adsorber (PSA) systems should comply with the appropriate Ph. Eur. monograph and the requirements given in Part A, Chapter 15, Table 29.

Sources of supply

Oxygen

2.5 For oxygen systems, the source of supply can be bulk liquid oxygen in a vacuum-insulated evaporator (VIE), liquid or gas cylinders, or an oxygen concentrator (PSA) system. When cylinder supply systems are used, the source of supply comprises a manifold that automatically changes from “duty bank” to “stand-by bank” to ensure continuity of supply.

2.6 An oxygen concentrator (PSA) system may be used to supply an oxygen pipeline system, even though the percentage concentration of oxygen is lower than that derived from liquid or gaseous sources, typically 94% or higher.

Nitrous oxide and nitrous oxide/oxygen

2.7 Nitrous oxide and nitrous oxide/oxygen mixture supply systems are usually supplied from a medical gas manifold system in two banks. When full, nitrous oxide cylinders contain liquid and gaseous product with a liquid/gaseous boundary; they must be used upright. Nitrous oxide can also be supplied by bulk liquid sources. Nitrous oxide/oxygen mixture could also be supplied by means of nitrous oxide and oxygen mixing systems, similar to those used for the production of synthetic air.

Medical air

2.8 For medical air systems used in respiratory applications, the source of supply can be:

- a medical gas manifold system;
- a medical compressor system; or
- an oxygen and nitrogen mixing system (referred to as a synthetic air plant).

When air-powered ventilators are used regularly, the consumption of air is high; cylinder supply systems are not recommended in these cases.

- 2.9 Emergency reserve manifold systems are provided for all gases.
- 2.10 Air or nitrogen for surgical tools is required at 700 kPa. The air supply can be provided by:
- an automatic manifold system;
 - a small, dedicated compressed-air system; or
 - a compressor plant supplying both medical and surgical air.

Note

Nitrogen for surgical power tools is likely to be used only on the sites where it is available for the production of synthetic air.

Medical vacuum

- 2.11 Medical vacuum is provided by means of a central vacuum plant. The vacuum system should always be used in conjunction with vacuum control units that include vacuum jars. In the event of inadvertent contamination of the pipeline systems resulting from vacuum jars overflowing, immediate action is required to clean the system before any fluids etc dry out. The procedure for cleaning vacuum systems is given in [Appendix D](#).

Distribution systems

- 2.12 Medical gases and vacuum are distributed throughout the hospital via the pipeline distribution system to provide gas (and vacuum) at the terminal units. Terminal units may be wall-mounted or installed within medical supply units, for example operating room pendant fittings, bedhead trunking and wall fittings that include other facilities such as nurse-call systems, connections for patient monitoring, electrical services, audio systems etc. Medical supply units should comply with the relevant sections of BS EN ISO 11197:2004.
- 2.13 The pipeline distribution system also includes area valve service units (AVSUs). These permit isolation of certain parts of the system for servicing or repair. They are also provided for use by clinical or nursing staff in an emergency. For example, in the event of a fire in a ward requiring patient evacuation or system damage to the extent that serious gas loss is occurring, the valve should be turned off to prevent further gas loss. Line valve assemblies (LVAs) are also included to permit isolation of larger parts of the system for modification and/or repair.

Warning and alarm systems

- 2.14 Warning and alarm systems are provided to give information to the staff who are responsible for operating the MGPS, changing cylinders, responding to plant faults, and to the medical staff responsible for the administration of medical gases and clinical users.

3 Medical gas pipeline standards

Standards relevant to medical gases

BS EN 737-1:1998. Medical gas pipeline systems. Terminal units for compressed medical gases and vacuum

- 3.1 This standard specifies the design requirements for their safe functioning. The primary elements in a terminal unit are a gas-specific probe and a socket with dimensions that are specific for each medical gas and for vacuum. The standard does not, however, actually specify these dimensions.
- Terminal units for oxygen, nitrous oxide, air for breathing and oxygen/nitrous oxide mixture (50%/50% v/v) must operate in a pressure range 320–600 kPa and be safe up to 1000 kPa.
 - Terminal units for air or nitrogen for driving surgical tools must operate in a pressure range 640–1200 kPa and be safe up to 2000 kPa.
 - Terminal units for vacuum must operate at a minimum absolute pressure of 10 kPa (76 mm Hg).
- 3.2 Terminal units have to be fitted with both a check valve and a separate maintenance valve, which may be manual or automatic. The leakage from the check valve must be less than 0.03 kPa L/min, which is close to 0.3 mL/min at atmospheric pressure. Limits for leakage from the maintenance valve are not specified.

BS EN 737-2:1998. Medical gas pipeline systems. Anaesthetic gas scavenging disposal systems. Basic requirements

- 3.3 This standard outlines the principles for active AGSS. Such systems differ from current UK systems in both flow rate range and terminal unit design (BS EN 737-4:1998). Flow ranges from 25 to 50 L/min with a maximum induced flow from the patient connection of 0.05 L/min; this compares with British Standard (BS) system specifications of 80 to 130 L/min and 0.5 L/min respectively.

- 3.4 Care must be taken to ensure that receiving systems designed under BS EN 737 are not used on BS systems, as excessive negative patient-applied pressures and noise may be generated.

BS EN 737-3:1998. Medical gas pipeline systems. Pipelines for compressed medical gases and vacuum

- 3.5 This standard specifies basic requirements for installation, function, performance, documentation, testing and commissioning of medical gas and vacuum pipeline systems to ensure patient safety by continuous delivery of the correct gas from the pipeline systems.
- 3.6 The list of medical gases covered is the same as that for EN 737-1.
- 3.7 Supply systems with mobile or stationary cryogenic vessels, with one or two vessels and a reserve supply, are permitted, and proportioning systems that use cryogenic liquid to generate synthetic air are specified. The standard permits air compressor systems that have three compressor units and no further reserve, provided that each compressor unit is capable of supplying the system design flow. Vacuum systems must have three or more vacuum pumps and be capable of supplying the system design flow with two units out of service.
- 3.8 Requirements are also given for area shut-off valves that must be located in boxes with a means to allow physical separation of the service for modification purposes. A gas-specific inlet (either NIST or a terminal unit) is also required downstream of each area shut-off valve.
- 3.9 Pipeline pressures must be 400–500 kPa for compressed medical gases, except air or nitrogen for surgical tools which has to be 700–1000 kPa. Vacuum is required to be <40 kPa absolute (<456 mm Hg).
- 3.10 Leakage from the carcass of medical gas pipelines is given as 0.025% per hour for 2 to 24 hours at 1.5 times the working pressure.

- 3.11 Leakage from a completed pipeline, with the terminal units attached, is specified by the following formula, which permits all terminal units to leak at the maximum rate given in BS EN 737-1:

$$pd = 2nh/V.$$

where:

pd = pressure drop;

n = number of terminal units;

h = hours on test;

V = volume of system.

Notes

This summary indicates that the general principles on which BS EN 737-3 is based are close to those of this Health Technical Memorandum. However, the scope of this Health Technical Memorandum is much wider than that of BS EN 737-3.

ISO 7396 'Pipelines for compressed medical gases and vacuum' will supersede EN 737.

BS EN 737-4:1998. Terminal units for anaesthetic gas scavenging systems

- 3.12 This standard covers the design of AGSS terminal units interfacing with BS EN 737-2 systems. BS EN 737-4 terminal units are not dimensionally compatible with BS 6834:1987 systems.

DD ENV 737-6:2003. Medical gas pipeline systems. Dimensions and allocation of probes for terminal units for compressed gases and vacuum

- 3.13 This document is an "ENV" document, implying that although it will be regarded as a European standard, member countries have the option of retaining their national probe standard, if justifiable reasons for its retention can be presented.
- 3.14 The dimensions in the standard represent a (shape-coded) probe that cannot fit into any of the existing medical gas terminal units in the EU. This will prevent commercial advantage in terminal unit production.
- 3.15 Currently, UK manufacturers produce probes dimensionally specified in BS 5682:2005 for use in the UK, and it appears that this will not change in the foreseeable future.

Compliance with European Directive 93/42/EEC

- 3.16 Both EN 737-1 and EN 737-3 conclude with tables showing how the clauses of the standard correspond to the essential requirements of European Directive 93/42/EEC, and with the statement that compliance with these clauses provides one means of conforming to the essential requirements of the directive.

BS EN ISO 11197:1998. Medical supply units

- 3.17 Medical supply units are defined as "prefabricated, permanently installed equipment intended to supply electric power and/or medical gases and/or liquids". Booms, ceiling pendants, wall systems and bedhead trunking systems are typical devices of this kind, which are frequently incorporated into gas pipeline systems.

BS EN 739:1998. Low pressure hose assemblies for use with medical gases

- 3.18 This covers the hoses commonly used to connect medical equipment to gas pipelines. This standard partially replaces BS 5682:1984, such that BS 5682 has been shortened and republished as BS 5682:1998 under the title 'Probes (quick connectors) for use with medical gas pipeline systems'.

BS EN 738-1:1997. Pressure regulators for use with medical gases. Pressure regulators and pressure regulators with flowmetering devices

- 3.19 This applies to:
- pressure regulators that are intended to be connected to free-standing high pressure cylinders of medical gas;
 - terminal units of medical gas pipelines; and
 - the high pressure regulators incorporated into devices such as anaesthesia machines and ventilators.
- 3.20 The requirements of the standard cover safety, compatibility with oxygen, pressure gauges, inlet and outlet connectors, relief valves, leakage, mechanical strength, filtration, performance and resistance to ignition.

BS EN 738-2:1999. Pressure regulators for use with medical gases. Manifold and line pressure regulators

- 3.21 This standard applies to pressure regulators which are intended for use within the supply systems of a

medical gas pipeline complying with BS EN 737. Manifold pressure regulators are intended for use with inlet pressures up to 200 bar and line pressure regulators to a maximum of 30 bar. The requirements of this standard cover the same topics as BS EN 738-1. However, the requirements for connectors are left to the discretion of the manufacturer, with the proviso that cylinder valve connections should not be used, since the regulators are not intended to be connected directly to cylinders.

BS EN 738-3:1999. Pressure regulators for use with medical gases. Pressure regulators integrated with cylinder valves

- 3.22 This applies to pressure regulators that are built into the cylinder valve and are typically used on small aluminium cylinders for home care. These regulators are provided with a filling port, so that the gas provider can refill a cylinder when it is empty. Most of the requirements of the standard are very similar to, or identical with, those of BS EN 738-1.

BS EN 738-4:1999. Pressure regulators for use with medical gases. Low pressure regulators intended for incorporation into medical equipment

- 3.23 This applies to low pressure regulators (maximum 1400 kPa) that are used in many different types of medical device. It seeks to ensure that the principles that have been defined in BS EN 738-1 are not overlooked when selecting components for other types of medical device.

Resistance to ignition

- 3.24 All four parts of BS EN 738 include requirements for resistance to ignition. For low pressure regulators (inlet pressure <3000 kPa), the requirement is that the auto-ignition temperature of components (including lubricants) that are in contact with the gas should not be lower than 160°C. A test method is described.
- 3.25 For high pressure regulators (inlet pressure <20,000 kPa), there should be no ignition or internal scorching after exposure to 20 pressure shocks at 24,000 kPa of oxygen, heated to 60°C. The shocks are of ten seconds' duration at 30-second intervals, with the regulator under specified conditions. These stringent tests are designed to reduce the frequency of regulator fires in future.

Note

It is likely that BS EN 738 will also be rewritten as a single (ISO) global Standard.

BS EN 13221:2000. High pressure flexible connections for use with medical gases

- 3.26 This applies to the flexible connections used to connect medical gas cylinders to manifolds, and states that non-metallic hoses should not be used, in addition to requirements for gas-specific connections and ignition and other safety-related items.

ISO 7396-1:2002 [under review]. Pipelines for compressed medical gases and vacuum [Replaces EN 737-3. Part 2 (AGSS) is in preparation.]

- 3.27 ISO 7396-1 specifies requirements for design, installation, function, performance, documentation, testing and commissioning of compressed medical gas and vacuum pipeline systems in healthcare facilities to ensure continuous delivery of the correct gas from the pipeline system.
- 3.28 It applies to:
- pipeline systems for the following medical gases: oxygen; oxygen-enriched air; nitrous oxide; air for breathing; carbon dioxide; oxygen/nitrous oxide mixtures; air for driving surgical tools; nitrogen for driving surgical tools; and to vacuum pipeline systems;
 - pipeline distribution systems for oxygen-enriched air connected to supply systems with oxygen concentrators complying with BS 7634:1993, ISO 10083:1992;
 - extensions and modifications of existing pipeline systems.
- 3.29 It does not apply to:
- gas-specific connectors on mobile or stationary cryogenic vessels or on transport vehicles, or on the inlet/outlet of cylinders for non-cryogenic liquid or gas;
 - medical gas pipeline systems supplying hyperbaric chambers.

BS EN ISO 14114:1999. Gas welding equipment. Acetylene manifold systems for welding, cutting and allied processes. General requirements

- 3.30 This covers the design and manufacture of acetylene manifolds for welding, cutting etc. The standard is not retrospective, but all repairs or modifications to existing systems should meet the new standard's requirements wherever possible.
- 3.31 The standard applies to acetylene manifold systems extending from the cylinder valve outlet connection to the connection of the flame arrestor. It applies to cylinder manifolds in which up to 16 single cylinders or two banks of eight cylinders are coupled for collective withdrawal.

Statutory obligations and other important documentation

- 3.32 Some of the more important documentation relating to medical gas systems is presented below. With much current work on standards, it is always wise to search the websites of the governing bodies to ensure that you possess the latest version of a particular standard.

The Pressure Equipment Regulations 1999

- 3.33 The Pressure Equipment Regulations 1999 apply to the design and construction aspects of pressure equipment intended to contain a gas or liquid at 0.5 bar or above. Assemblies of such equipment (that is, a pressure system) are also covered.

Note

The Pressure Systems and Transportable Gas Containers Regulations 1989 have been replaced by The Pressure Equipment Regulations 1999 and the Pressure Systems Safety Regulations 2000.

The Pressure Systems Safety Regulations 2000

- 3.34 These regulations apply mainly to the in-service aspects of pressure systems such as operation and periodic examination. They also deal with design and construction aspects of systems that are outside the scope of the Pressure Equipment Regulations 1999.
- 3.35 The Pressure Systems Safety Regulations 2000 cover pressure systems containing a relevant fluid that is:
- a gas above 0.5 bar;

- a liquid with a vapour pressure of 0.5 bar or greater at either its working temperature or 17.5°C;
- steam at any pressure.

- 3.36 The Health and Safety Executive's (HSE) (2000) 'Safety of pressure systems. Pressure Systems Safety Regulations 2000. Approved Code of Practice L122' supports the requirements of the regulations.

- 3.37 The requirements contained within an HSE Approved Code of Practice are not law, but the Code does have special legal status.

Basic MGPS requirements

- A **written scheme of examination** for the MGPS is required by the Regulations. The scheme defines the type, frequency and extent of examination of specific parts of the medical gas system, particularly those classified as pressure vessels, for which a two-yearly internal visual inspection is usually required.
- A **competent person** is required to prepare this written scheme. The competent person may be an organisation, and will usually be a nominated person from the insurance company that carries out periodic pressure vessel inspections. (This is not the Competent Person (MGPS) defined under the permit-to-work system in this Health Technical Memorandum.)
- Pressure safety valve replacement scheme (five-yearly)**. This advice arises from the inherent lack of corrosion of these components when used with the very dry gases in the MGPS, and is an alternative to pressure testing, which requires MGPS shut-downs and could be dangerous if line pressures were to be increased during patient use. Details of the procedure should appear in the written scheme.

The Control of Substances Hazardous to Health (COSHH) Regulations 2002

- 3.38 These regulations are the main piece of legislation covering control of the risks to employees and other people arising from exposure to harmful substances generated out of, or in connection with, any work activity under the employer's control. The main objective of the regulations is to reduce occupational ill-health by setting out a simple framework for controlling hazardous substances in the workplace.

- 3.39 COSHH requires employers to ensure that the exposure of their employees to substances hazardous to health is either prevented or, where this is not reasonably practicable, adequately controlled to ensure that exposure standards are not exceeded.
- 3.40 Essential to the COSHH process is the performance of a risk assessment, or review of an existing one, identifying the anaesthetic agents used, staff most likely to be exposed, and existing exposure control methods.
- 3.41 Combinations of general ventilation, AGSS and local exhaust systems may be required in extreme cases to ensure compliance with COSHH.
- 3.42 Anaesthetic agents were assigned occupational exposure standards (OESs) by the HSE. These are listed below:

Anaesthetic agent	OES ppm over an 8-hour time-weighted average (TWA) reference period
Nitrous oxide	100
Enflurane	50
Isoflurane	50
Halothane	10

Legal requirement

- 3.43 The exposure of staff to anaesthetic agents must be controlled to the OES in accordance with the requirements of COSHH. The HSE are empowered to enforce the standards, taking into account attempts to comply as soon as is reasonably practicable.
- 3.44 Staff should be reminded of the need to reduce leaks from the MGPS and anaesthetic equipment to a minimum.
- 3.45 Other guidance applies:
- the HSE's (2002) 'EH40/2002 – Occupational exposure limits 2002';
 - the HSE's (1996) 'Anaesthetic agents: controlling exposure under COSHH'.
- 3.46 An electronic version is available on <http://www.coshh-essentials.org.uk/>

Management of Health and Safety at Work Regulations 1999

- 3.47 These regulations necessitate formal risk assessment by employers in relation to the health and safety of

Note 1

Although the OES values quoted above are extant, there is a possibility that the OES for nitrous oxide exposure may be reduced. It is not clear which level will be adopted, but both 50 ppm and 25 ppm eight-hour TWAs (time-weighted averages) have been suggested.

Note 2

OESs for nitric oxide, nitrogen dioxide and sulphur dioxide were removed from EH40 in the 2003 supplement. Levels for these are now suggested as being no greater than 1 ppm, and limits for SO₂ exposure as being less than 1 ppm for both 8 hour TWA OES and 15 min STEL.

These limits are, of course, in excess of the current Ph. Eur. specifications for the respective contaminant levels in medical air.

their employees and others, arising from work activities.

Workplace (Health, Safety and Welfare) Regulations 1992

- 3.48 Accidents in the workplace arising from lack of a safe working environment resulted in the production of these regulations, which are particularly relevant to maintenance and access provision.

Provision and Use of Work Equipment Regulations 1998

- 3.49 These regulations relate to another aspect of accidents in the workplace – those related to the provision of safe equipment and safety in its use – and will apply, for example, to accidents resulting from improperly serviced test equipment used with an MGPS.

Manual Handling Operations Regulations 1992

- 3.50 These regulations (as amended by the Health and Safety (Miscellaneous Amendments) Regulations 2002) cover the handling and transportation of medical gas cylinders.
- 3.51 A risk assessment should be performed for all situations. Manual handling training is essential for all staff handling medical gas cylinders.
- 3.52 The British Compressed Gas Association's (BCGA) Guidance Note GN3 – 'Safe cylinder handling

and the application of the Manual Handling Operations Regulations to gas cylinders' defines the principles of safe practice for the handling of compressed and liquefied gas cylinders. It explains how compliance with the Manual Handling Regulations may be achieved.

Personal Protective Equipment at Work Regulations 1992

- 3.53 These regulations apply to MGPS operation and maintenance, for example the use of special clothing when working with cryogenic plant, and replacing bacteria filters on central medical vacuum plant. Protective equipment used when handling cylinders is also covered. Operatives must be trained in the correct use of safety equipment.

Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) 1995

- 3.54 These regulations are applicable to all work areas and will encompass an MGPS if, for example, the system delivers the wrong gas to a patient. Forms F2508 and F2508A may be applicable.

Electromagnetic Compatibility Regulations 2005

- 3.55 These regulations apply to the protection of electrical equipment from electromagnetic fields and other interference, and of equipment designed to prevent or reduce such emissions.

BSI Quality Assurance Schedule QAS 3720.1/206/A

- 3.56 This quality assurance schedule is a means of easily identifying companies capable of designing and installing an MGPS. The scheme is currently under review, and is likely to be revised to include both component specifications and work on dental compressed air and vacuum systems. Companies wishing to tender for work on MGPS should provide evidence of registration under BS EN ISO 9001, with the scope of registration defined as design, installation, commissioning and maintenance, as appropriate.

BS EN ISO 13485:2003. Medical devices. Quality management systems. Requirements for regulatory purposes

- 3.57 A standard, based on BS EN ISO 9001:2000 and superseding BS EN 13485:2001 and BS EN 13488:2001, that is being adopted by MGPS equipment suppliers and installers.

The Medicines Act 1968

- 3.61 Under the Medicines Act 1988, medical gases are classified as medicinal products and are therefore subject to the same procurement and quality procedures as all other medicinal products.
- 3.62 The pharmaceutical quality controller is responsible for quality control of medical gases.
- 3.63 Medical gases and vacuum systems must not be used for non-medical purposes, other than as a power source for medical equipment or for testing medical equipment.

Defect and failure reporting for non-medical equipment, engineering plant, installed services and building fabric

- 3.64 The Department of Health's (DH) Estates and Facilities Division has produced the document DH (2006) 01 – 'Reporting defects and failures and disseminating Estates and Facilities alerts'. The purpose of this document is to remind trusts of the importance of reporting defects and failures involving non-medical devices. All staff working in a healthcare environment have a responsibility to report to the Department of Health defects or failures that occur at work.
- 3.65 This document provides guidance on:
- actions required;
 - what defects and failures are reportable;
 - definition of reportable defects and failures;
 - how reporting should be carried out;
 - what should happen to defective/failed items;
 - what actions Estates and Facilities will take.
- 3.66 Visit the following link for more detailed information: <http://www.dh.gov.uk/assetRoot/04/12/76/35/04127635.pdf>

4 Functional responsibilities

General

- 4.1 This chapter describes the roles and responsibilities of key personnel involved in the operation, maintenance and use of an MGPS. The job titles given are generic; they are not intended to be prescriptive job titles for terms of employment. Indeed, some of the personnel referred to may not be resident staff but people employed by outside bodies and working on contract (for example those employed by a facilities management organisation or PFI consortium).
- 4.2 Some staff will have other responsibilities unconnected with MGPS, and in some cases the same individual may take on more than one role.
- 4.3 In all cases, however, it is essential to identify an individual who will take on the responsibility for the day-to-day management of the MGPS and become the Authorised Person (MGPS).

Note

In order to avoid confusion with other Authorised Persons, such as the Authorised Person for high voltage installations, the Authorised Person for the MGPS will be referred to as the Authorised Person (MGPS) throughout this Health Technical Memorandum.

- 4.4 There may be times when an Authorised Person (MGPS) is unavailable to manage the MGPS. In such circumstances it is essential that adequate Authorised Person (MGPS) cover is provided to enable the MGPS to function effectively at all times.
- 4.5 This Health Technical Memorandum recommends that Authorised Persons (MGPS) should be invested with the responsibility for ensuring that the MGPS is operated safely and efficiently.
- 4.6 An Authorised Person (MGPS) in liaison with the Quality Controller (MGPS) will decide whether an MGPS should be taken into or out of use.

Management – definition

- 4.7 Management is defined as the owner, occupier, employer, general manager, chief executive, or other person who is ultimately accountable for the safe operation of the premises. In PFI/facilities-managed premises, the PFI/FM consortium may directly employ estates staff. However, appointment of an Authorised Person (MGPS) to manage the MGPS will still be necessary.

Key personnel

- 4.8 The following are the key personnel who have specific responsibilities within the MGPS operational policy:
 - a. Executive Manager;
 - b. Estates/Operations Manager;
 - c. Authorising Engineer (MGPS);
 - d. Authorised Person (MGPS);
 - e. Competent Person (MGPS);
 - f. Quality Controller (MGPS);
 - g. Designated Medical Officer (MGPS) or Designated Nursing Officer (MGPS).

Executive Manager

- 4.9 The Executive Manager is defined as the person with ultimate management responsibility, including allocation of resources and the appointment of personnel, for the organisation in which the MGPS are installed.
- 4.10 Depending on the nature of the organisation, this role may be filled by the general manager, chief executive, laboratory director or other person of similar authority.
- 4.11 The formal responsibility for the MGPS rests with the Executive Manager, although the Authorised Person (MGPS) retains effective responsibility for day-to-day management of the MGPS.

- 4.12 The Executive Manager is responsible for the implementation of an operational policy for the MGPS. He/she should ensure that the MGPS operational policy clearly defines the roles and responsibilities of all personnel who may be involved in the use, installation and maintenance of the MGPS. The Executive Manager is also responsible for monitoring the implementation of the policy.
- 4.13 The Executive Manager may delegate specific MGPS responsibilities to key personnel; the extent of such delegation should be clearly set out in the MGPS operational policy together with the arrangements for liaison and monitoring.
- 4.14 In most organisations, the Authorised Person (MGPS) will take responsibility for the preparation, implementation and monitoring of the MGPS operational policy, and will involve senior medical and nursing personnel.

Estates/Operations Manager

- 4.15 The Estates/Operations Manager holds responsibility for the integrity of the MGPS. In a typical NHS trust employing direct labour, there may be one or more Authorised and Competent Person(s) (MGPS) with clear line management responsibility.
- 4.16 In situations where the Authorised and Competent Person(s) (MGPS) are contracted to the trust, or are employed by the PFI/FM consortium, it will be necessary to identify a function within the organisation that is analogous to the estates management function within the trust. Within this function, senior management will appoint Authorised and Competent Persons (MGPS): the former on the recommendation of an independent Authorising Engineer (MGPS) and the latter following assessment by the Authorised Person(s) (MGPS) within the organisation.
- 4.17 The Estates/Operations Manager should also monitor the implementation of the MGPS operational policy. In particular, the MGPS should comply with the requirements of this Health Technical Memorandum and all work should be carried out in accordance, where possible, with the permit-to-work procedures.

Authorising Engineer (MGPS)

- 4.18 This engineer should be suitably qualified in accordance with the requirements of [Chapter 7](#) of this Health Technical Memorandum.

- 4.19 This person will have specialist knowledge of MGPS, in particular the MGPS for which an Authorised Person (MGPS) will assume responsibility on appointment. He/she acts, and is employed, independently of organisations submitting potential Authorised Persons (MGPS) for assessment.
- 4.20 The Authorising Engineer (MGPS) will, subsequent to performing an assessment of a potential Authorised Person (MGPS), recommend to the Executive Manager of the submitting organisation either that the person is able to proceed to written appointment or requires further training.

Authorised Person (MGPS)

- 4.21 The Authorised Person (MGPS) is defined as that person designated by the Executive Manager to be responsible for the day-to-day management of the MGPS at a particular site or sites. This includes the issue of permits in accordance with the permit-to-work procedure. The principal responsibilities of the Authorised Person (MGPS) in respect of the permit-to-work procedure are set out in [paragraph 6.91](#). The Authorised Person (MGPS) also has specific duties with regard to VIE installations (see [Appendix E](#)).
- 4.22 All Authorised Persons (MGPS) should be appointed in writing by the Executive Manager on the recommendation of an Authorising Engineer (MGPS). An individual assessment of the suitability of the potential Authorised Person (MGPS) will be required before such a recommendation can be made.
- 4.23 Procedures using permits for the authorisation of work require the fullest cooperation of all staff, and their acceptance of the responsibilities involved. The Authorised Person (MGPS) should take the lead in coordinating the work and explaining fully the extent and duration of any disruption to the service. They should also ensure that all contractors follow the procedures set out in the permit.
- 4.24 The Authorised Person (MGPS) is responsible for ensuring that:
- a. all Designated Nursing Officers (MGPS) likely to be involved are advised within a reasonable timescale of the estimated duration of the work and any required interruption to the MGPS;

- b. all terminal units affected, that is, out of service, are appropriately labelled with “danger do not use” notices.

- 4.25 Arrangements should be made to ensure that cover for an Authorised Person (MGPS) is always available, particularly during holidays and other absences.
- 4.26 The Authorised Person (MGPS) is required to liaise closely with other professionals in various disciplines, and consequently the appointment should be made known in writing to all interested parties. He/she should have direct contact with the Quality Controller (MGPS), users and other key personnel.
- 4.27 The Authorised Person (MGPS) is responsible for assessing the competency of all Competent Persons (MGPS) employed directly by the estates/operations department and for maintaining a list of Competent Persons (MGPS).
- 4.28 The Authorised Person (MGPS) is responsible for ensuring that work is carried out only by approved specialist contractors registered to BS EN ISO 9001/BS EN 13845, with scope of registration defined as design, installation, commissioning, validation, verification and maintenance of MGPS as appropriate. Evidence of current registration should be by sight of the certificate of registration.
- 4.29 The Authorised Person (MGPS) should be consulted before the purchase of any medical equipment that will be connected to the MGPS.

Appointment of Authorised Persons (MGPS)

- 4.30 All Authorised Persons (MGPS) will be appointed on the recommendation of an Authorising Engineer (MGPS).
- 4.31 This Authorised Person (MGPS) may be appointed from within:
 - a. the directly employed workforce of the trust with overall responsibility for the healthcare establishment;
 - b. a neighbouring trust;
 - c. the PFI/FM contractor;
 - d. a specialist MGPS contractor working as a subcontractor to the PFI/FM organisation;
 - e. a specialist agency offering Authorised Person (MGPS) services.

- 4.32 In trusts responsible for more than one healthcare establishment, it is possible to draft Authorised Person services from one site to another. This would apply to provision of Authorised Person (MGPS) services from, say, a large acute hospital to smaller community hospitals and hospices. It will be the responsibility of the trust employing the “peripatetic” Authorised Person (MGPS) to ensure that relevant contractual and insurance issues are resolved and that the Authorised Person (MGPS) is given ample opportunity to familiarise himself/herself with the additional site(s).

- 4.33 This arrangement can also be used on PFI/FM sites where the PFI/FM contractor has no directly employed Authorised Person (MGPS). However, if none of the trust’s properties employs an Authorised Person (MGPS), it will be necessary to contract in an Authorised Person (MGPS) from one of the bodies listed in (b), (d), or (e) in paragraph 4.31.

- 4.34 In trusts with only a single site, the Authorised Person (MGPS) may be employed by the trust as a member of the estates staff, or as in (b), (c), (d) or (e) in paragraph 4.31.

- 4.35 Establishments with no directly employed Authorised Person (MGPS) and no PFI/FM contractor involvement (for example some community and hospice sites) will prove the most difficult in terms of MGPS management, because – should an Authorised Person (MGPS) be immediately unavailable subsequent to an emergency breakdown or pipeline failure – the site’s senior manager will need to identify a site-based person with sufficient MGPS expertise to sign permits-to-work. This staff member should receive training in the safety aspects of medical gases and application of the permit-to-work system, and all permits completed by this staff member should be examined by the Authorised Person (MGPS) at the earliest opportunity.

Note

Although it may be possible for the contractor’s Competent Person (MGPS) to effect repairs within a relatively short period (for example two hours), it may not be possible for an Authorised Person (MGPS) to attend the site during this period. In these circumstances it will be necessary for a member of the (hospice) staff to sign the permit to allow work to continue.

- 4.36 With smaller units, the cost of these services can be considerable in terms of overall budget; it is the responsibility of the service providers to do all that is reasonably practicable to ensure cost-effective provision while maintaining the required level of safety. Where applicable, members of the unit staff should be trained in the safety aspects of medical gases and application of the permit-to-work system.
- 4.37 Potential providers of Authorised Person (MGPS) services are reminded that:
- Authorised Person (MGPS) appointments cannot be made unless recommended by a registered Authorising Engineer (MGPS);
 - this registration will require proof of familiarity with the area(s) of responsibility of the Authorised Person (MGPS);
 - appropriate professional and public liability insurance must be carried.

Coordinating Authorised Person (MGPS)

- 4.38 On a large site, there could be several Authorised Persons (MGPS). In this case, the Executive Manager should appoint one as the Coordinating Authorised Person (MGPS) with overall responsibility for the site.
- 4.39 The Coordinating Authorised Person (MGPS) will coordinate the actions of all other Authorised Persons (MGPS) within his/her area of responsibility and will manage the permit-to-work system and other MGPS safety aspects in that area.

Competent Person (MGPS)

- 4.40 The Competent Person (MGPS) is the person who carries out the installation and/or maintenance work on the MGPS. A list of his/her responsibilities and duties is set out in [paragraph 6.92](#). The Competent Person (MGPS) should have received appropriate training and should be on a list of Competent Persons (MGPS). In the case of directly employed labour, this list should be held by the Authorised Person (MGPS); in the case of contracted labour, it should be held by the contractor's Authorised Person (MGPS) or project manager.

Assessment of competency of the Competent Person (MGPS)

- 4.41 The Competent Person (MGPS) may be a member of a specialist contractor's staff or of the estates department.

- 4.42 Competent Persons (MGPS) must be able to demonstrate skills in MGPS maintenance and/or installation in accordance with nationally accredited guidelines.
- 4.43 Where the Competent Person (MGPS) is a member of the estates department, the Authorised Person (MGPS) is responsible for assessing the competency of the Competent Person (MGPS) with respect to work on the MGPS.
- 4.44 Where Competent Persons (MGPS) are members of a contractor's staff, the contractor is responsible for assessing the competence of those staff and maintaining a register of Competent Persons (MGPS).

Note

The Competent Person as defined in the Pressure Systems Safety Regulations 2000 is not the same person as the Competent Person (MGPS) defined in this Health Technical Memorandum. The former is a chartered engineer responsible for drawing up a written scheme of examination for the system. The latter is the person who will carry out installation, maintenance or modifications.

Quality Controller (MGPS)

- 4.45 The Quality Controller (MGPS) is the person designated as the quality controller for MGPS. He/she is responsible for the quality control of the medical gases at the terminal units and plant such as medical air compressors, oxygen concentrators and synthetic air systems.
- 4.46 The Quality Controller (MGPS) will accept the professional responsibility for the last independent check of an MGPS that, if faulty, could cause critical clinical consequences to patients.
- 4.47 The Authorised Person (MGPS), in conjunction with the chief pharmacist, should contact the Quality Controller (MGPS) when testing of MGPS is required. Authorised Persons (MGPS) contracting in Quality Controller (MGPS) services should ensure that documentary evidence of continuing and recent experience in MGPS testing is provided before a contract is finalised.
- 4.48 The Authorised Person (MGPS) will need to liaise with the Quality Controller (MGPS) before an MGPS can be taken into use, as quality tests may be required before gases are passed to patients; the

specific tests and requirements are set out in Chapter 15, Part A.

- 4.49 Guidance on appointing Quality Controllers (MGPS) to carry out quality-control testing of MGPS is given in [Chapter 7](#). This chapter also contains guidance on eligibility for registration on the Quality Controller (MGPS) register maintained by the NHS Pharmaceutical Quality Assurance Committee.

Designated Medical Officer (MGPS) or Designated Nursing Officer (MGPS)

- 4.50 The Designated Medical or Nursing Officer (MGPS) (hereafter Designated Officer (MGPS)) is the person in each department with whom the Authorised Person (MGPS) liaises on any matters affecting the MGPS and who would give permission for a planned interruption to the supply.
- 4.51 It is essential that there is liaison between the medical and nursing staff that use the MGPS and the Authorised Person (MGPS) to ensure that the MGPS is appropriate to their needs.
- 4.52 The Designated Officer (MGPS) should give permission for any interruption to the MGPS and should sign the appropriate parts of the permit-to-work.
- 4.53 The MGPS operational policy should clearly set out the requirements for such permission, including the circumstances dictating signature by either the Designated Medical Officer (MGPS) or Designated Nursing Officer (MGPS).
- 4.54 The Designated Officer (MGPS) and the Authorised Person (MGPS) are responsible for ensuring that all clinical/nursing staff are aware of the interruption to the MGPS and which terminal units cannot be used.
- 4.55 There should ideally be a Designated Officer (MGPS) for every department; the MGPS operational policy should list the Designated Officers (MGPS) and the arrangements for cover due to absences of the Designated Officers (MGPS).
- 4.56 The Designated Officer (MGPS) acts as the focal point for communications related to the MGPS and advises on any special requirements for his/her department relating to MGPS, such as provision of emergency cylinders and vacuum pumps.
- 4.57 The Designated Officer (MGPS) would normally carry out the appropriate action in the event of an emergency (for example isolation of a ward supply); such actions should be set out in the MGPS operational policy.
- 4.58 All Designated Officers (MGPS) should have received training on the MGPS relevant to their departments and on the action to be taken in the event of an emergency.
- 4.59 The MGPS operational policy should set out the training requirements as defined in [paragraphs 7.43–7.45](#).

5 Operational policy

General

- 5.1 Many of the difficulties arising from failure of medical gas supplies can be avoided if operational protocols are in place before emergencies arise.
- 5.2 It is recommended that an operational policy should be prepared. This should be based on a fully documented compliance survey in which the MGPS is examined in the light of current requirements, particularly those of this Health Technical Memorandum.
- 5.3 Any deficiencies are highlighted and become the subject of risk assessments where current risks are analysed and solutions recommended along with re-assessed risk levels.
- 5.4 Each risk is then attributed a priority level, and high-priority risks are summarised and used to develop a remedial action plan.
- 5.5 The operational policy will be based on the system at the time of the survey. Many of the procedures it contains will be aimed at minimising identified risks. Some of these risks will disappear as the system is brought up to specification. For this reason the operational policy must not be seen as a “static” document; rather, it will change to reflect the needs of staff managing and using the MGPS.
- 5.6 Guidance on how to prepare an operational policy is given in [Appendix A](#). This is followed by a sample operational policy in [Appendix B](#).

Responsibilities for policy preparation and updating

- 5.7 The Executive Manager is responsible for the operational policy, although responsibility for policy preparation and implementation will usually be delegated to the Authorised Person (MGPS).
- 5.8 To ensure that the policy is regularly updated, it will contain a protocol for the review process. Fundamental to this is the establishment of a medical gas committee, comprising, as a minimum, the Authorised Person (MGPS), the Quality

Controller (MGPS) and representatives from clinical and nursing specialties. Other members (for example health and safety officers) can be coopted as necessary.

- 5.9 Such a group should meet at least once a year to review the policy, but a procedure for immediate updating of, for example, contact details must operate regardless of the meeting frequency. Usually, the Authorised Person (MGPS) chairs the meetings and reports minutes to the chief executive.
- 5.10 Separate policies or procedures are sometimes prepared to supplement the operational policy. It is acknowledged that some trusts have separate procedures that are referenced within the operational policy under the control of specific departments (for example cylinder management under the control of the pharmacy department).
- 5.11 The Executive Manager is responsible for ensuring that the operational policy is being properly updated. This should be carried out regularly, and the procedure for updating should be set out in the policy.
- 5.12 The responsibility for monitoring specific aspects is often delegated to appropriate key personnel. For example, the responsibility for monitoring the implementation of the permit-to-work procedure would normally be delegated to the Estate Manager/Authorised Person (MGPS). The details of such delegation should be set out in the operational policy.

Operational considerations

System limitations

- 5.13 The operational policy should ensure that users are aware of the capacity of the system and any particular limitations; for example, a 400 kPa medical air system supplied from a cylinder manifold system is unlikely to sustain the use of respiratory ventilators.

- 5.14 Similarly, changes in patient ventilation regimes can affect the capacity of systems. For example, adoption of continuous positive airway pressure (CPAP) ventilation can lead to a significant increase in consumption of oxygen.
- 5.15 Where PSA systems are installed, medical staff will need to take account of the reduced oxygen concentration when using medical equipment and be aware of possible increases in concentration if the emergency reserve manifold is in operation.
- 5.16 MGPS provide gases at terminal units of a microbiological quality that is adequate for virtually all applications. There may be exceptional events, for example patients receiving immuno-suppressive drugs, where additional precautions may be required. Staff should be advised that this could be most readily achieved by incorporating an appropriate bacteria-retentive filter in the breathing system.
- 5.17 Staff must be advised not to use medical gases for non-medical purposes other than as a test gas for medical equipment.
- 5.18 Medical air should be used as the power source for medical equipment such as ventilators. The routine use of oxygen as a driving gas is to be avoided. Venturi suction devices may also be powered from a medical air system, but large-scale connection of such devices to the system is not recommended, as air consumption is high and there is also potential for generation of microbially contaminated aerosols; a central medical vacuum system is the preferred alternative. Oxygen should not be used, except in an emergency.

System hazards

- 5.19 Users should be aware not only of the chemical hazards of any of the gases/gas mixtures delivered by the MGPS, but also of the consequences of the loss of any of the services or the formation of incorrect mixtures.
- 5.20 Users of 700 kPa surgical systems should be aware of the stored energy of gas in the connecting assembly (hose) and should take care to avoid the hazard of rapid ejection of probes when disconnecting tools.

Emergencies

- 5.21 The operational policy should set out the procedures to be followed in the event of an emergency. This should include the following:
 - a. reporting an incident;
 - b. action to be taken (for example turning off isolation valves, use of portable emergency cylinders);
 - c. liaison with other staff and departments;
 - d. calling out contractors.
- 5.22 All alarm systems should be clearly labelled and all staff should be trained in the appropriate action to be taken in the event that an alarm is initiated.
- 5.23 Staff responsible for plant operation should be aware of the activities necessary to ensure the continued safe operation of the system and what action should be taken in an emergency. The Authorised Person (MGPS) in particular should take a lead in explaining to users the function of the system, and he/she will have to be adequately trained and informed about the system (see [Chapter 7](#)).
- 5.24 They should be similarly familiar with the purpose of AVSUs and how to use them in an emergency.
- 5.25 Power supply failure, changeover to emergency and reinstatement of normal supply may cause control systems on plant items such as compressors and manifolds to change to a default condition. When such changeover occurs, staff should ensure that, for example, manifold cylinder contents accord with the alarm signal status and, in the case of compressor and PSA systems, the duty and stand-by conditions are as selected.

Medical equipment

- 5.26 The MGPS operational policy is not intended to be applied to the use, maintenance etc of patient-connected equipment except when the use of such equipment may influence the operation of the MGPS.
- 5.27 The Authorised Person (MGPS) should be consulted before the purchase of any medical equipment that will be connected to the pipeline.

Note

This is to ensure that the MGPS has sufficient capacity and can deliver the required flows at the specified pressures.

It is particularly important that the Authorised Person (MGPS) should be consulted before any new equipment, such as patient ventilators, is connected to the medical air 400 kPa system, to ensure that the system capacity is not exceeded.

- 5.28 Certain ventilators can also have a significant effect on the capacity of oxygen systems, particularly those operating under CPAP.
- 5.29 The policy should state the procedures to be followed and the personnel who need to be consulted before a new item of medical equipment is connected to the MGPS. The following examples are typical:
- where gas blenders are used at point of use, for example with patient ventilators, the manufacturer's instructions should be followed with regard to operation and maintenance, to prevent contamination of a pipeline in the event of equipment malfunction. Further details are given in [Chapter 10](#);
 - some older types of blending equipment can allow backflow from one pipeline to another, leading to, for example, oxygen enrichment of medical air systems or reduction of oxygen content in oxygen pipelines. When not in use, blenders should be disconnected;

Note

BS ISO 11195:1995 'Gas mixers for medical use. Stand-alone gas mixers' was developed to avoid this problem.

- portable suction units should be used in areas where there is a possibility that the vacuum system could become contaminated. Such areas would include infectious disease units. The need for portable suction units should be discussed with the control of infection officer.
- 5.29 Before any maintenance work is carried out on any medical equipment, including portable suction units, the equipment should be appropriately decontaminated. A "certificate of decontamination" may be required.

- 5.30 In some accommodation, medical gas equipment is installed within enclosures or behind decorative panels to provide a more domestic environment. In these cases, it is essential that identification is maintained so that staff are aware that equipment is available for patient use. Staff should also ensure that gas supplies are turned off, blenders are disconnected, and suction jars removed and cleaned before any equipment is concealed.

Gas quality requirements

- 5.31 Medical gases supplied from cylinder or liquid sources should comply with the Ph. Eur. PSA systems should accord with the recommendations given in Chapter 15, Part A. All other gases or medical gas mixtures should comply with the product licence specification held by the gas supplier.
- 5.32 Pharmacy staff have a responsibility for monitoring the quality of all gases delivered, including PSA, compressed air and synthetic air. It may be appropriate to include warning systems within the pharmacy department.
- 5.33 There is growing interest in the concept of mixing oxygen and nitrogen on-site from liquid sources for the provision of medical synthetic air. Given the concerns about inner-city pollution, this concept may offer advantages over conventional compressor systems.

Control of work

- 5.34 Any work involving alterations, extensions or maintenance work on the system should be subject to the permit-to-work procedure set out in [Chapter 6](#), which should be under the control of the Authorised Person (MGPS).

Responsibility for gas cylinders

- 5.35 The responsibility for gas cylinders should be clearly defined in the operational policy. This would include the training of personnel in the correct procedures for cylinder handling, storage and transportation. The procedures in [Chapter 8](#) should be followed.

Record drawings

- 5.36 The estates department should have accurate and up-to-date drawings of the MGPS showing main sections and branches, departments served, control

valves, terminal units and alarm systems for each medical gas service.

- 5.37 These drawings should be readily available on site for use by any Authorised Person (MGPS), and all Authorised Persons (MGPS) should know their location.
- 5.38 Each isolating valve should be individually identified by a unique reference number. The appropriate reference number, corresponding to that shown on the drawings, should be displayed at or on each isolating valve. The drawing should indicate the type and make of terminal units.
- 5.39 A schematic diagram of the installation should be provided.
- 5.40 When additions or alterations are to be made to existing installations by a contractor, the Authorised Person (MGPS) should provide an adequate number of prints from the master drawing as agreed with the contractor. On completion of the work, the contractor should return to the Authorised Person (MGPS) at least one copy of an amended print, indicating pipework alterations etc. The Authorised Person (MGPS) should arrange for the master MGPS drawing to be updated. In some cases it may be part of the contract agreement that an amended as-fitted drawing is provided by the contractor to then replace the original master drawing.

Note

Up-to-date drawings and records are required under the Pressure Systems Safety Regulations 2000.

Locking of valves and plantrooms for MGPS

- 5.41 All valves on the MGPS, except those in plantrooms, should be secured in such a way that they can normally be locked in the closed or open position.
- 5.42 In the case of those valves that may have to be operated in an emergency (for example AVSUs), the locking system should be capable of being overridden.
- 5.43 Medical gas plantrooms should be kept locked, except when work is in progress in them.
- 5.44 Plantrooms containing medical gas cylinders should be kept locked, with a prominently displayed notice indicating the location of the spare key.
- 5.45 For access to plantrooms, see Chapter 14, Part A.
- 5.46 The valves in the liquid oxygen installation need not be kept locked. The gate to the liquid oxygen installation should be kept locked, and an indestructible and clear notice stating the location of the key should be securely fixed to each gate of the installation. The fire brigade should be informed of the location of the key.
- 5.47 The procedure for keeping keys, described in the MGPS operational policy, should be followed.

Contractors

- 5.48 All contractors should comply with the trust or building safety policy. This should be clearly stated in the operational policy.
- 5.49 Work on pipelines should only be carried out by specialist firms registered to BS EN ISO 9001/ BS EN ISO 13485, with scope of registration defined as design, installation, commissioning and maintenance of the MGPS, as appropriate. Evidence of registration should be by sight of the current certificate of registration.
- 5.50 The operational policy should set out the responsibilities for monitoring the work of contractors. This would normally be coordinated by the Authorised Person (MGPS). The procedures for calling out a contractor, particularly in the event of a fault or an emergency, should also be set out in the operational policy.

6 Operational procedures and the permit-to-work system

- 6.1 Safety rules and procedures for an MGPS are necessary to ensure that the integrity and performance of the system are maintained.
- 6.2 The purpose of the permit issued under this permit-to-work system is to safeguard the integrity of the MGPS and hence, patient safety; it is not intended as a permit to protect the safety of individuals operating or working on the system. In some cases there may be additional safety procedures to be followed under the Health and Safety at Work etc Act 1974 or COSHH.
- 6.3 A permit-to-work should always be issued before any work is carried out on the MGPS. The permit should identify the work to be carried out, and will provide documentary evidence that a system is only taken back into use when all tests have been satisfactorily completed.
- 6.4 Managing the permit-to-work system is one of the responsibilities of the estates department. The Authorised Person (MGPS) who has day-to-day responsibility for the MGPS will be responsible for the implementation of the permit-to-work system. On sites where several Authorised Persons (MGPS) operate, the coordinating Authorised Person (MGPS) should manage the permit-to-work system.

Application of the system

- 6.5 The permit-to-work system is applicable to the servicing (including planned preventive maintenance (PPM)), repair, alteration and extension of existing MGPS within a hospital, and any action, such as the closure of an isolating valve, which restricts the supply.
- 6.6 Permits should also be issued before any major item of central plant, for example manifold, control panel, compressor or vacuum pump (including any stand-by plant), is isolated before servicing, repair or overhaul.
- 6.7 A permit should be issued for all PPM work on the MGPS. This includes all examinations where no interruption to the service is anticipated.

- 6.8 Specimen permit forms are shown in **Figures 1 and 2**.

Scope of permit

- 6.9 The extent of the work is specified on the permit.
- 6.10 The permit should not be amended. If changes to the work are required, a new permit should be issued.

Form of permit

- 6.11 Permits are presented in book or electronic format.

Book format

- 6.12 These contain multiple copies, numbered consecutively. Each permit will comprise the following:
 - a. copy 1 (**white, top copy** – permanent) remains in the permit book and carries all original signatures (it is to be retained by the Authorised Person (MGPS) on completion of the work);

Note

For legal purposes, this copy bears all original signatures. It should be completed in black indelible ink.

- b. copy 2 (**pink** – tear-out) is given to the Quality Controller (MGPS) on completion of the work;
- c. copy 3 (**yellow** – tear-out) is given to the Competent Person (MGPS) (it may be returned to the Authorised Person (MGPS) on completion of the work if not needed by the Competent Person (MGPS));
- d. copy 4 (**green**) – only with high hazard permits – is used to sketch point of isolation.

Full guidance on how to use the permits is given in **Appendix G**.

Coding system for recording test systems

- 6.13 The list of tests that appeared on previous Health Technical Memorandum 2022 permits has been removed, as it was simply a listing of the full range of commissioning tests.
- 6.14 The new permits allow users to write down a short description of the tests, which should reflect more accurately the work carried out on the MGPS. As an alternative to writing down the tests, a coding system may be used (see [Appendix G](#)).

Electronic format

- 6.15 These forms are included in proprietary systems. For further details, see the Department of Health Estates and Facilities Division's Knowledge and Information Portal (<http://www.knowledge.nhsestates.gov.uk>).

Note

For high hazard permits, a fourth (green) sheet carrying a schematic of the part of system to be isolated and, in particular, valve(s) to be isolated **must** be retained with the permit. The Authorised Person (MGPS) **must** discuss the content of this fourth sheet with the Competent Person (MGPS) **before** the work begins, and a copy **must** be taken to the site of isolation, where it should be consulted by both the Authorised Person (MGPS) and the Competent Person (MGPS) **before** isolation takes place.

Isolation of plant and pipeline system

- 6.16 The Authorised Person (MGPS) is responsible for witnessing the isolation of valves/AVSUs/LVAs and for making safe the plant or system to be worked on. No section of an MGPS should be worked on, filled with inert shield gas or pressure-tested, unless it is adequately isolated from any section in use or available for use.
- 6.17 Physical isolation, by means of a “break point” (additional to the isolating valve ball mechanism) at the “supply” end of the section to be worked on, is essential except in the case of routine terminal unit component replacement (for example seals/second-fix assemblies). In this latter example, isolation of the valve controlling the terminal units will suffice. (This may be the automatic isolating valve integrated into the first-fix part of BS 5682/BS EN 737-1 type terminal units, or the ward AVSU when servicing non-BS/EN terminal units.)

- 6.18 An AVSU/LVA is designed to provide a physical break. This is done by the closure of the valve mechanism and the fitting of a downstream blanking spade. In older systems without AVSUs, a physical break must be established by closure of the appropriate valve, followed by cutting and capping of the pipe stub attached to the downstream side of the valve.

Situations not requiring issue of a permit-to-work

Emergencies

- 6.19 In the event of an emergency such as a fire or a major medical gas leak, a doctor or nurse should isolate the affected section by closing the AVSUs, and then inform the Authorised Person (MGPS) as soon as possible, as remedial work will require the issue of a permit.
- 6.20 The emergency procedures set out in the MGPS operational policy should be followed. There may be occasions when emergency repairs using mechanical connectors will be performed without subsequent pharmaceutical testing, for example outside normal working hours. It is essential that a permit be issued for this work, as it is remedial work subsequent to isolation. It is also essential that the Quality Controller (MGPS) agrees that such procedures can take place without subsequent full quality test routines and that the procedure is documented in the MGPS operational policy.

Replacement of cylinders/recharging of cryogenic liquid storage vessels

- 6.21 Permits are not necessary for the routine replacement of cylinders on manifolds nor for the recharging of cryogenic liquid supply systems, provided there is no danger of the supply being disrupted when these tasks are undertaken. It is essential that portering staff responsible for cylinder replacement receive appropriate training in these techniques.

Commissioning of a new MGPS

- 6.22 Permits are not intended to be used during commissioning of a new MGPS installation. However, a situation may arise during commissioning where part of a new MGPS has passed all commissioning tests but is then modified for some reason. In these circumstances, it is essential that both Authorised Person (MGPS) and

Figure 1

MEDICAL GAS PIPELINE SYSTEMS – HIGH HAZARD PERMIT TO WORK – in accordance with HTM 02

Hospital/Trust _____
Delete as applicable*

Permit No 06/67890

Part 1 Description of work by Authorised Person and permission to proceed from Designated Medical/Nursing Officer

The following work is to be carried out.

Drawing reference No _____ Spec No _____ Dated _____

The work will take place between _____ hours on _____ and _____ hours on _____ and will affect medical gas pipelines supplying (Circle gas(es))

O ₂	N ₂ O	O ₂ /N ₂ O	MA	SA/SN ₂	VAC	AGSS	He/O ₂	CO ₂
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to the following area(s):

Supplies are*/will be* isolated*/reinstated* at

Valve(s) No(s) _____ Location(s) _____

AP (MGPS) Name (print) _____ Sign _____ Date _____ Time _____

AP (MGPS) taking over.

Name (print) _____ Sign _____ Date _____ Time _____

Clinical/Nursing permission is required for this work and is granted by

DMO/DNO Name (print) _____ Sign _____ Date _____ Time _____

Ward/Dept _____

NO OTHER WORK WILL BE CARRIED OUT UNDER THIS PERMIT

Part 2 CP (MGPS) acceptance of work and conditions

I accept responsibility for the work as described.

No other work will be carried out by me or persons working under my control.

I am fully conversant with the work described and relevant fire and safety requirements.

Other Permits to be used Type _____ No _____ during this work:

Type _____ No _____

CP (MGPS) Name (print) _____ Sign _____ Date _____ Time _____

CP (MGPS) taking over. Name (print) _____ Sign _____ Date _____ Time _____

Part 3 Confirmation of work completion, HTM 02 engineering test results and readiness for pharmaceutical testing

Work described in Part 1 has been completed and the following engineering tests have been carried out.

TEST	P/F	TEST	P/F	TEST	P/F

I have advised the AP (MGPS) of all work and tests carried out and provided details of the installation. Test results are*/are not* satisfactory.

The installation has been left in a safe condition.

CP (MGPS) Name (print) _____ Sign _____ Date _____ Time _____

The system is*/is not* ready for pharmaceutical testing. This Permit is hereby cancelled*

AP (MGPS) Name (print) _____ Sign _____ Date _____ Time _____

Comments (Sign and date)

Part 4 Pharmaceutical tests and authorisation to use system

GAS	O ₂	N ₂ O	N ₂ O/O ₂	MA	SA/SN ₂	VAC	AGSS	He/O ₂	CO ₂
	P/F	P/F	P/F	P/F	P/F	P/F	P/F	P/F	P/F
Purging and filling									
Gas Identity									
Gas Quality									
Particulate matter									
Pipeline Odour									

Comments (Sign and date)

The test results are*/are not* satisfactory. The system may*/may not* be taken into use.

QC (MGPS) Name (print) _____ Sign _____ Date _____ Time _____

AP (MGPS) Name (print) _____ Sign _____ Date _____ Time _____

Part 5 Acceptance of system status by Designated Medical/Nursing Officer

I declare that all aspects of the work have been explained to me. I hereby accept that the system is ready*/not ready* for service and I will undertake to advise all the appropriate staff of this service status.

DMO/DNO Name (print) _____ Sign _____ Date _____ Time _____

Ward/Dept _____

Original (white) copy to be retained in book by Authorised Person (MGPS)
Pink copy to Quality Controller (MGPS)
Yellow copy to Competent Person (MGPS)
Green copy to be retained in book by Authorised Person (MGPS)

HTM 02-01 PW2 Ver 1.0

Figure 2

MEDICAL GAS PIPELINE SYSTEMS – **LOW** HAZARD PERMIT TO WORK – in accordance with HTM 02

Hospital/Trust _____
Delete as applicable*

Permit No 06/67890

Part 1 Description of work and authorisation/permission to proceed

The following work is to be carried out.

The work will take place between _____ hours on _____ and _____ hours
on _____ and will*/will not* affect terminal units supplying (Circle gas(es))

O ₂	N ₂ O	O ₂ /N ₂ O	MA	SA/SN ₂	VAC	AGSS	He/O ₂	CO ₂
----------------	------------------	----------------------------------	----	--------------------	-----	------	-------------------	-----------------

to the following area(s):

NO OTHER WORK WILL BE CARRIED OUT UNDER THIS PERMIT

WARD SUPPLIES WILL*/WILL NOT* BE ISOLATED FOR WORK ON ALARMS*/TERMINAL UNITS*

AP (MGPS) Name (print) _____ Sign _____ Date _____ Time _____

AP (MGPS) taking over.
Name (print) _____ Sign _____ Date _____ Time _____

Clinical permission is*/is not* required for the work described and is granted by*

DMO/DNO Name (print) _____ Sign _____ Date _____ Time _____

Ward/Dept _____

DMO/DNO Name (print) _____ Sign _____ Date _____ Time _____

Ward/Dept _____

DMO/DNO Name (print) _____ Sign _____ Date _____ Time _____

Ward/Dept _____

Part 2 CP (MGPS) acceptance of work and conditions

I accept responsibility for the work as described.

No other work will be carried out by me or persons working under my control.

I am **fully conversant** with the work described and relevant fire and safety requirements.

CP (MGPS) Name (print) _____ Sign _____ Date _____ Time _____

CP (MGPS) taking over.
Name (print) _____ Sign _____ Date _____ Time _____

Part 3 Confirmation of work completion and HTM 02 engineering test results

Work described in Part 1 has been completed and the following HTM 02 engineering tests have been carried out.

TEST	P/F

I have advised the AP (MGPS) of all work and tests carried out and provided details of the installation.

Test results are*/are not* satisfactory.

The installation has been left in a safe condition.

CP (MGPS) Name (print) _____ Sign _____ Date _____ Time _____

Part 4 AP (MGPS) authorisation to use system

The system may be taken into use.*

The system may not be taken into use, as further work under a new Permit is now necessary*

AP (MGPS) Name (print) _____ Sign _____ Date _____ Time _____

Part 5 Acceptance of system status by Designated Medical/Nursing Officer

I declare that all aspects of the work have been explained to me. I hereby accept the system back into service and will advise all the appropriate staff that the service has been reinstated.*

I understand that further work on the system is now required and will ensure that all patients likely to be affected by this work will have alternative provision and/or will not be put at risk.*

DMO/DNO Name (print) _____ Sign _____ Date _____ Time _____

Ward/Dept _____

DMO/DNO Name (print) _____ Sign _____ Date _____ Time _____

Ward/Dept _____

DMO/DNO Name (print) _____ Sign _____ Date _____ Time _____

Ward/Dept _____

Original (white) copy to be retained in book by Authorised Person (MGPS)
Pink copy to Quality Controller (MGPS)
Yellow copy to Competent Person (MGPS)

HTM 02-01 PW1 Ver 1.0

Quality Controller (MGPS) have a record of the new work and any necessary procedures subsequent to its completion. The use of the permit in these circumstances can be considered for control and record purposes.

Quarterly quality control testing of medical and surgical air

- 6.23 Permits are not required for the routine quality control tests of medical and surgical air. These tests, which should be carried out every three months, require samples of air to be taken at the plant test point and (at the discretion of the Quality Controller (MGPS)) other points in the system. The results of these tests should be retained by both Quality Controller (MGPS) and Authorised Person (MGPS). Unsatisfactory results may warrant shut-down of plant and remedial repairs. These should be covered by issue of a permit. The Authorised Person (MGPS) should liaise with the Quality Controller (MGPS) on the extent of QC testing that will be required after major work on a medical or surgical air plant.

Permit-issuing authority and control of permits

- 6.24 The permit-issuing authority should be an Authorised Person (MGPS). On a large site where several Authorised Persons (MGPS) operate, the coordinating Authorised Person (MGPS) and a nominated deputy may assume responsibility for issuing permits for the whole site. Such an arrangement should be documented in the MGPS operational policy.
- 6.25 In exceptional circumstances, the following may sign a permit:
- an Authorising Engineer (MGPS) in the absence of an Authorised Person (MGPS). However, the Authorising Engineer must be familiar with the system for which the permit is to be issued;
 - on a small site (for example a hospice) where no Authorised Person (MGPS) is immediately available; for example, during an emergency repair, a site-based person with sufficient MGPS technical expertise may sign (see paragraph 4.35).
- 6.26 A new book of permits should not be taken into use until the old book is completely used and accounted for. The permits should be consecutively numbered. Photocopies of a blank permit should

not be used in lieu of a new book, unless published copies are unavailable.

- 6.27 No additional permit(s) should be issued for work already in force. The original work must be completed or cancelled before a new permit is issued.

Time and place of issue

- 6.28 Permits should only be issued to Competent Persons (MGPS) immediately before work is to start and at the point of work. This requirement does not prevent prior discussion of the work between the Authorised Person (MGPS) and Designated Officers (MGPS), as this is essential to ensure effective management of the work.

Life of permit (active and completed copies)

- 6.29 The permit should remain in force until the work is completed, the permit fully signed and the MGPS taken back into use.
- 6.30 For work lasting many weeks (for example isolation of a ward/department for refurbishment), the Authorised Person (MGPS) will decide whether the work is best covered by two permits (one for isolation of the system to be upgraded and another for its reconnection) or a single permit covering all the work.
- 6.31 All original copies of the permit (and any accompanying safety method statements, special instructions, other relevant permits etc) should be retained by the Authorised Person (MGPS) in a file dedicated to MGPS documentation.
- 6.32 Completed permits should be kept for the life of the MGPS.

Receiving authority

- 6.33 Permits should only be issued to a Competent Person (MGPS), that is, contractors' or estates staff and artisans who are to be engaged in work on the MGPS.
- 6.34 If an Authorised Person (MGPS) performs the work described on the permit, they will have to sign as the Competent Person (MGPS) on the relevant parts of the permit.

Responsibility for work

- 6.35 A Competent Person (MGPS) accepting a permit is, from that moment, responsible for the safe

conduct of the work within the limits of the permit, but the work will be subject to supervision by the Authorised Person (MGPS) and relevant testing procedures on completion.

- 6.36 The Competent Person (MGPS) should be fully conversant with its terms and requirements and should give sufficient and clear instructions to staff working under his/her supervision.
- 6.37 Contracts should be only placed with firms who are appropriately registered as described in [paragraph 5.49](#). Further guidance on contractors' competence etc is given in [Chapter 10](#).
- 6.38 The Competent Person (MGPS) should not leave the work site during the lifetime of the permit. However, if this is inevitable, for example if the work is halted between shifts, the Competent Person (MGPS) must ensure that suitable precautions have been taken to ensure the safety of the system and any personnel who may enter the work area during this period. If it is necessary for further work to be carried out by another Competent Person (MGPS) (for example during a further shift), this Competent Person (MGPS) must not only sign the "CP (MGPS) taking over" section of part 2 of the permit, but also sign the fourth sheet (green copy).

Limits of authorisation

- 6.39 The permit should provide concise and accurate information about when and where it is safe or dangerous to work. It should provide a clear statement of the work to be done. The estimated time for completion should also be given, but this is for guidance purposes only and should not prejudice the completion of the work in complete safety. The fourth sheet (green copy) of the permit will provide an illustration of the isolation to be carried out.
- 6.40 The Competent Person (MGPS) should not be persuaded to break the conditions or scope of the permit, for example by attempting work not covered by the permit.
- 6.41 The scope of the actual work done should be limited to that described in the permit, and no-one should change the description of the work.

Cancellation of permits before completion of work

- 6.42 In the event of a change in the programme of work or any reason leading to cancellation of the existing permit (for example unsatisfactory engineering or

pharmaceutical test results), the Competent Person (MGPS) must return the yellow copy of the permit to the Authorised Person (MGPS), who will insert it into the permit book and write "cancelled" across all permits (white, yellow and pink, and – in the case of high hazard work – the schematic on the green fourth page).

- 6.43 The cancelled permit should be accompanied by a written statement from the Authorised Person (MGPS) describing the stage at which the work was stopped and the reason why.
- 6.44 The Competent Person (MGPS) and Authorised Person (MGPS) must ensure that the system is left in a safe condition.
- 6.45 If there is to be a delay before issue of another permit and resumption of work, the Competent Person (MGPS) (and any assistants) must remove all tools and equipment and leave the site in a safe condition.
- 6.46 The Authorised Person (MGPS) must notify the Designated Officer (MGPS) of the situation and arrange alternative supplies if necessary.
- 6.47 To complete the work, a completely new permit should be issued, and this should be cross-referenced to the original permit approval by suitable wording in part 1 of the new permit.

Loss of permits

- 6.48 If the yellow copy of the permit is lost by the Competent Person (MGPS), the Authorised Person (MGPS) must be informed so that the loss can be recorded on the white, pink and, where appropriate, green copies in the permit book.
- 6.49 The Competent Person (MGPS) must countersign and date these copies.
- 6.50 All other signatories should sign both of the remaining (pink and white) copies on completion of relevant elements of the work. New copies of any safety method statements should be attached to the remaining (white) permit book copy if original copies of these documents are also lost. The Quality Controller (MGPS) will be given the pink copy, when it has been fully signed, along with copies of any appropriate documentation.

Typographical errors

- 6.51 These should be crossed through, corrected and initialled by the Authorised Person (MGPS).

Maintaining contact with the Authorised Person (MGPS)

- 6.52 It is essential that all staff involved with work on the MGPS carry identification at all times, and that the Authorised Person (MGPS) is available for contact at any time during the work and subsequent testing.

Permission for work to take place

- 6.53 Work on an MGPS that will lead to interruption of supplies will require signing of the permit by a Designated Medical Officer (MGPS) or Designated Nursing Officer (MGPS) before the work can take place. Minor works on plant, for example oil changes that do not result in loss of service, will not require this signature. These procedures must be documented in the MGPS operational policy.
- 6.54 The MGPS operational policy will also define the extent of responsibility of Designated Officers (MGPS) when signing MGPS permits. For example, a Designated Nursing Officer (MGPS) may be given responsibility for a whole hospital, multiple wards or just a single ward. Designated Medical Officers (MGPS) are often involved if the gas supply to a whole department is to be shut down, although some hospitals operate the permit system without Designated Medical Officer (MGPS) intervention. The hazard level of the work may also be used to determine who gives written permission for work to proceed. These agreements should be recorded in the MGPS operational policy. Training in roles and responsibilities is a key element of the satisfactory application of the permit system.

Advance notice of work

- 6.55 There should be general agreement between the Authorised Person (MGPS) and the Designated Officers (MGPS) on the length of advance notice which will normally be required before interruptions to gas supplies may be made. This might be (typically) 48 hours for fully preplanned work to allow for any necessary patient/equipment movement that may be required. These agreements should be recorded in the MGPS operational policy.
- 6.56 The Authorised Person (MGPS) should describe to the Designated Officer (MGPS) the extent to which the MGPS will be restricted or interrupted while the work is in progress, and should indicate the level of hazard involved. The Authorised Person

(MGPS) should also explain that a signature of a Designated Officer (MGPS), on duty at the time of the start of the work, will be required on the permit to allow the work to take place.

Maintaining services during the work

- 6.57 The Authorised Person (MGPS) should assist as necessary to ensure that a service is maintained whilst the MGPS is disrupted. This may require the provision of alternative gas supplies, for example cylinder/regulator combinations and/or portable suction units. Additional cylinder supplies/equipment may need to be ordered for this purpose, and liaison with portering/pharmacy/medical engineering departments may be necessary.

Essential liaison with the Quality Controller (MGPS)

- 6.58 It is essential that the Quality Controller (MGPS) be informed well in advance of work that will involve quality and/or identity testing.
- 6.59 The extent of the work and any potential problems should be discussed so that the Quality Controller (MGPS) may determine the likely staffing/time requirements of the task.
- 6.60 The Authorised Person (MGPS) should make available all necessary pipework and as-fitted drawings, and state which gases are involved to allow the Quality Controller (MGPS) to select appropriate test equipment.
- 6.61 The Authorised Person (MGPS) must arrange for the Quality Controller (MGPS) to have access to the system when testing is required, as delays will be inevitable if this cannot be provided.
- 6.62 The Authorised Person (MGPS) should ensure that all necessary engineering tests have been completed with satisfactory results before QC testing takes place.
- 6.63 If the testing is to be carried out by a Quality Controller (MGPS) who is not employed on site (for example a contracted-in Quality Controller (MGPS) from another hospital within the trust or an employee of a specialist MGPS testing organisation), they should introduce themselves, and any colleagues, to the senior staff in the areas they will be testing.
- 6.64 If testing is carried out by a specialist MGPS testing organisation, the Authorised Person (MGPS) and local Quality Controller (MGPS) must liaise with

that organisation to ensure that appropriate protocols are followed, preferably by sight of a suitable safety method statement. Copies of test results should be retained by the local Quality Controller (MGPS) and the Authorised Person (MGPS) following the validation and verification process.

Accompanying documents

- 6.65 Depending on the work to be carried out, other documents may be attached to the permit, in order to ensure that all safety aspects have been considered before the work starts. These will include:
- safety method statements, describing the work methodology and accompanying safety precautions;
 - other permits related to the work, for example “hot work” and “confined spaces” (the MGPS permit should include reference(s) to these by permit number(s));
 - an up-to-date set of as-fitted drawings of the system(s) to be worked on and any other drawings relevant to the proposed work;
 - any special instructions or additional safety measures relevant to the work or its environment.

These documents will be retained by the Authorised Person (MGPS) in the MGPS document file.

Levels of hazard

- 6.66 Whenever work is to be carried out on the MGPS, it is assigned a level of hazard depending on the nature of the work.
- 6.67 It is important to appreciate that the hazard level relates to risks to the patient, not to the system maintainer or operative.
- 6.68 The Authorised Person (MGPS) assesses the hazard level at the time of preparing the permit and, if in doubt, will assess the hazard at the higher level.
- 6.69 Two levels of hazard are defined in paragraphs 6.70–6.90.

High hazard work

- 6.70 High hazard work is work on any part of the MGPS that introduces hazards of pollution and/or cross-connection or isolation of a patient supply

other than for servicing terminal unit second-fix components.

- 6.71 High hazard work will require subsequent tests for gas quality and/or identity and performance of fittings etc (including the ability to deliver the designed gas flow).
- 6.72 Cutting and brazing a pipeline is classified as high hazard, as it is clear that both cross-connection and pollution are possible consequences of the work.
- 6.73 There are instances where a cross-connection hazard may arise but the risk of system pollution is very small. Examples would be the servicing of terminal units with interchangeable components (that is, those not designed to BS 5682:1998 specifications) and the moving of pendants containing flexible hoses fitted with mechanical connectors (NISTs).
- 6.74 Replacement of pendant hoses also carries a risk of cross-connection should NIST fittings be incorrectly attributed to a hose. This is a possibility when hose assemblies are not colour-coded as recommended in [Chapter 10](#). In this situation, the performance of a simple anti-confusion test by use of, for example, AVSUs and gas-specific probes may suffice; a gas identity meter check may be waived at the discretion of the Quality Controller (MGPS).
- 6.75 If the risk of pollution is negligible and that of cross-connection is minimised by operational procedures, testing with a gas identity meter may not be necessary.
- 6.76 Servicing of terminal units containing interchangeable components is a typical example. As these types of terminal unit may also require isolation of a ward, the risk of cross-connection can be minimised by replacing seals on the one gas system that has been depressurised. Other systems remain pressurised during the work. If formal gas identity meter-testing is not carried out, final proof of correct identity must be proved by mechanical testing using gas-specific proofing tools (for example certified gas-specific terminal unit probes).
- 6.77 In all such cases, it is essential that procedures are agreed with the Quality Controller (MGPS) and are documented in the MGPS operational policy.
- 6.78 Isolation of, say, a single compressor, or even a complete compressor system, for an oil change would be classified as low hazard, provided that the emergency reserve supply is active, capable of supplying system demand, and monitored during plant isolation.

- 6.79 By agreement with the Quality Controller (MGPS), emergency repairs using mechanical connectors specified in Chapter 13, Part A can be considered as a low hazard. However, efforts should be made to ensure that the section of pipework affected is purged of any debris that may have entered during either the incident or the repair process. Where multiple adjacent pipelines have been damaged simultaneously, it will be necessary to ensure that the insertion of mechanical couplings to effect a repair does not lead to any cross-connection.
- 6.80 A vacuum system could be crucial to patient welfare. Complete isolation of a vacuum system is therefore classified as high hazard work, and will require provision of portable vacuum pumps and/or ejector-type vacuum units.

Low hazard work

- 6.81 This applies to all work on the MGPS that does not give rise to a high hazard situation.
- 6.82 Low hazard permits will cover all PPM inspections, but some remedial work may require issue of a high hazard permit; for example, examination of a leaking terminal unit may reveal that the supply to the ward will require isolation in order to allow replacement of a damaged first-fix component.
- 6.83 Much low hazard work will involve maintenance of terminal units either on a PPM basis or as an emergency repair (replacement of second-fix components).
- 6.84 Terminal units that comply with BS 5682:1998/ BS EN 737-1:1998 incorporate components such as indexing pins and shapes which are gas-specific. It is therefore not possible to assemble the terminal unit in such a way that the wrong gas is delivered (other than by a wilful act). Servicing of these terminals is therefore low hazard work. However, during re-assembly the gas-specific features should be checked to ensure that they have not been damaged. The removal of gas-specific features from second-fix assemblies (for example locating pins) must not be used as a method of overcoming incorrectly installed first-fix components.
- 6.85 Terminal units complying with BS 5682:1998 include an automatic isolating valve. Some earlier terminal units include a manual isolating valve.
- 6.86 When working on individual terminal units fitted with an integral isolating valve or check valve (which operates automatically when the socket assembly is removed), it is not usually necessary to interrupt the supply to other adjacent terminal units.
- 6.87 Terminal unit termination blocks should not be left unattended with the socket removed, unless a blocking plate has been attached.
- 6.88 Much work on plant will be of low hazard. However, work on plant that carries a potential risk of pollution to the gas supply must be discussed with the Quality Controller (MGPS) before proceeding with the work. For example, a strip down of an air compressor for, say, piston replacement will not cause any interruption to the supply, as the secondary plant and emergency reserve manifold are available for use during the work. However, it would be unreasonable to return the refurbished plant into service without discussing possible QC tests with the Quality Controller (MGPS).
- 6.89 In some cases, the hazard level may appear high, for example changing bacteria filters on a central vacuum plant. However, this task would be classified as low hazard, as patient risk is low, even though maintenance staff should take special precautions against infection.
- 6.90 Risks to personnel working on the MGPS may arise from the work procedures or work environment, for example microbiological exposure, brazing (hot work) and work in confined spaces. Working with these risks may require issue of additional permits appropriate to the risks. These permits may run concurrently with the MGPS permit, and they should be referenced on part 1 of the MGPS permit.

Responsibilities of the Authorised Person (MGPS) for the permit-to-work procedure

- 6.91 The responsibilities of the Authorised Person (MGPS) are as follows:
- obtaining written permission (where appropriate) from Designated Officers (MGPS) for interruption of supplies and affixing “do not use” or other prohibition notices;
 - preparing permits and (where appropriate) any additional documents, for example safety method statements;
 - explaining details of work to the Competent Person (MGPS);

- d. supplying drawings of existing sections of the installation (as-fitted drawings);
 - e. supervising isolation of the section on which work is to be carried out;
 - f. witnessing, supervising or accepting results of tests of completed work as appropriate;
 - g. supervising purging with working gas(es);
 - h. assisting the Quality Controller (MGPS) in final quality and/or identity testing, in the case of high hazard work;
 - j. witnessing, supervising or accepting results of final performance tests of completed work in the case of low hazard work;
 - k. supervising or making the final connection of any extension;
 - m. restoring the gas service(s) by operation of appropriate valves/AVSUs/LVAs;
 - n. notifying the Designated Officer (MGPS) of completion of work and removal of “do not use” notices;
 - p. obtaining corrected copy of drawings;
 - q. supervising amendments of office copy of as-fitted drawings;
 - r. retaining original copy of permit and all permit books;
 - s. obtaining the Designated Officer (MGPS)’s signature on the permit, accepting the system as fit for service.
- f. signing the permit, declaring that the work is completed as indicated. Copy 3 (yellow copy) of the permit must be returned to the Authorised Person (MGPS) and placed in the permit book for final signing;
 - g. in the case of contractors, providing an appropriate safety method statement applicable to the work, evidence of compliance with relevant quality assurance requirements, and a company health and safety policy.

Responsibilities of the Designated Officers (MGPS)

6.93 The responsibilities of the Designated Officers (MGPS) are as follows:

- a. signing the permit to agree that the system can be taken out of use (this will not be necessary for some low hazard permits – see [paragraph 6.53](#));
- b. advising other clinical/nursing staff that the system is not available for use;
- c. on completion of the work, signing the permit and accepting the system back into use;
- d. advising clinical colleagues and departmental heads that the system is/is not available and fit/unfit for use.

Responsibilities of the Quality Controller (MGPS)

6.94 The Quality Controller (MGPS) is involved in testing after high hazard work and other work at his/her discretion. The responsibilities of the Quality Controller (MGPS) are as follows:

- a. identifying the test equipment required, depending on the specific service that has been disrupted (this equipment should be maintained and calibrated to accredited standards);
- b. carrying out final quality and/or identity tests on the systems;
- c. signing the permit, declaring that the pharmaceutical testing is completed as indicated and that the system may be put into use.

Responsibilities of the Competent Person (MGPS) for the permit-to-work procedure

6.92 The responsibilities of the Competent Person (MGPS) are as follows:

- a. signing the permit, acknowledging responsibility for the work;
- b. obtaining and understanding instructions on work to be done;
- c. isolating sections of the system on which work is to be carried out (under direct supervision of the Authorised Person (MGPS));
- d. carrying out the work;
- e. carrying out system integrity tests on completed work (under direct supervision of the Authorised Person (MGPS) where appropriate);

The permit form

6.95 Two classifications of permit, in accordance with the defined hazard levels, are used:

- High hazard permit: this form is divided into five parts and requires signatures of the Authorised Person (MGPS), Competent Person (MGPS), Designated Officer (MGPS) and the Quality Controller (MGPS);
- Low hazard permit: this form is divided into five parts and is simpler than the high hazard permit, as QC testing of work covered by the permit is not required.

- 6.96** In some instances (for example changing oil/filters on plant), there will be no interruption to supplies and no Designated Officer (MGPS) signature will be required. In other instances, although the work is of a low hazard nature, a Designated Officer (MGPS) signature must be obtained, as entry to patient areas and interruption of gas supplies will be required (for example servicing of terminal units).
- 6.97** Both forms are described in paragraphs 6.98–6.143 along with relevant comments on completion.

High hazard permit

- 6.98** The space on the top left of the form allows for entry of the hospital/trust name.

Part 1

- 6.99** This contains information on the work to be done, permission from a Designated Officer (MGPS) for it to take place, and an assurance that no other work will be carried out during the life of the permit. This description should relate directly to the sketch shown on the fourth sheet (green copy) of the permit and any accompanying drawings (see paragraph 6.101).
- 6.100** The system or systems affected by the work, an approximate timescale, and the areas in which the work is to take place, or will be affected, are also listed here.
- 6.101** Wherever possible, drawing reference numbers (and their dates) should be identified on the permit, and copies of the relevant drawings should be attached plus a sketch showing the isolation point drawn on the fourth sheet of the permit. If the description of the work is considerable, it can be extended to a separate sheet stapled to the permit. A copy of any safety method statements and other permits (hot work and confined spaces etc), signed and dated by the Authorised Person (MGPS), should also be attached.

- 6.102** The Quality Controller (MGPS) should also be sent a copy of any additional sheets. This part of the form also contains space for the predicted timescale of the work and the signature of the Designated Officer (MGPS).

- 6.103** Safe isolation is essential; the Authorised Person (MGPS) is expected to provide minimum details of the isolation point as follows:

- valve box number;
- valve box key number;
- valve box location;
- area/name of ward etc to be isolated;
- gas to be isolated.

- 6.104** The Authorised Person (MGPS) signs and dates part 1 at the time of discussion with the Designated Officer (MGPS), but the latter should be informed that they will not be expected to sign part 1 until the day the work is to take place. This allows for final consultation with the clinical/nursing staff on duty and confirmation that the work is able to take place.

- 6.105** The Quality Controller (MGPS) should also be informed that high hazard work is to take place and that his/her attendance will be required for testing purposes.

- 6.106** The Authorised Person (MGPS) should re-examine the permit while inspecting the installation to make sure the possibility of unexpected cross-connection has been carefully considered.

Part 2 (together with the fourth sheet)

- 6.107** This is for the Competent Person (MGPS) to sign at the location of the work, just before the work is due to start. The yellow copy and fourth sheet of the permit are presented to the Competent Person (MGPS), who will read – questioning anything not understood – then sign both, accepting responsibility for the work and any other staff working under his/her supervision. It is the duty of the Authorised Person (MGPS) to ensure that the Competent Person (MGPS) understands that no other work should be undertaken during the life of the permit. He/she should also sign the fourth sheet at this time.
- 6.108** It is also important to ensure that the Competent Person (MGPS) is fully informed of, and conversant with, any special safety measures/

procedures which may be in force during the work (for example isolation of fire/smoke detectors and operation of fire-fighting equipment).

- 6.109 It is important that a safety method statement is produced to cover the work.
- 6.110 The yellow copy of the permit should be placed in a protective cover and given to the Competent Person (MGPS) for the duration of the work. The fourth sheet should be retained by the Authorised Person (MGPS) and kept in the permit book.

Part 3

- 6.111 The installation must be ready for examination by the Authorised Person (MGPS) at this stage. Part 3 is signed on completion of the work by the Competent Person (MGPS) including, where appropriate, any testing relevant to the work. The Authorised Person (MGPS) must exercise discretion as to whether he/she wishes to take part in the testing routines.
- 6.112 The Authorised Person (MGPS) should satisfy himself/herself that the work has been carried out as prescribed. This may be by actually witnessing the appropriate tests carried out by the Competent Person (MGPS) or by examining the completed test record sheets. Part 3 of the permit should be filled in by the Competent Person (MGPS) to indicate a “pass” or “fail” status for each test performed in order to enable the Authorised Person (MGPS) to make an informed decision on the suitability of the system for pharmaceutical testing. At this stage, failure of one or more tests will usually indicate that further work on the system will be required. In these circumstances, the Authorised Person (MGPS) signs to indicate that the system will not be suitable for pharmaceutical testing and cancels the permit. It is the duty of the Competent Person (MGPS) at this stage to ensure that all steps are taken to ensure that the system is left in as safe a condition as possible. In the case of serious faults, for example extensive internal oxidation of the pipeline, it may be necessary for the Competent Person (MGPS) to leave site while the situation is resolved. In such cases, all tools and materials not required for the purposes of any investigation should be removed from site.
- 6.113 The Competent Person (MGPS) returns to the permit book and, with the Authorised Person (MGPS), signs part 3 of the white copy (the yellow copy is in place in the book to allow transfer of text).

- 6.114 The inside cover of the permit book contains a list of relevant tests. If desired, the code attributed to each test can be entered into the “test” box on part 3. A selection, or all, of these tests may follow the work, depending on its complexity.
- 6.115 The Authorised Person (MGPS) will then supervise reconnection of the isolated system and any purging with the working gas.
- 6.116 At this stage, the Quality Controller (MGPS) may be present and may request that the Authorised Person (MGPS) carry out the purge process, or may wish to involve himself/herself in the procedure.
- 6.117 The Authorised Person (MGPS) then invites the Quality Controller (MGPS) to carry out the identity and quality tests.

Part 4

- 6.118 This is completed by the Authorised Person (MGPS) and the Quality Controller (MGPS) when satisfied that the system may be taken back into use. The new permit requires only one signature from each. Multiple initials by test boxes are no longer required. Only the tests carried out should be written down.
- 6.119 The Authorised Person (MGPS) then informs the Designated Officer (MGPS) that the work is completed and that the MGPS is now ready for use.

Part 5

- 6.120 This is signed by the Designated Officer (MGPS), accepting the system back into use or, in the case of a “failed” system, not accepting the system as suitable for use and agreeing to notify his/her colleagues to this effect.
- 6.121 The Authorised Person (MGPS) should remove any “do not use” or other prohibition labels and retain the book containing white and green copies of the permit.
- 6.122 The second (pink) copy of the permit should be given to the Quality Controller (MGPS). The Competent Person (MGPS) may wish to keep the yellow copy, but the fourth sheet should remain in the permit book.

Low hazard permit

- 6.123 The space on the top left of the form allows entry of the hospital/trust name.

Part 1

- 6.124 The system or systems affected by the work and the areas in which the work is to take place, or will be affected, are listed here.
- 6.125 The Authorised Person (MGPS) signs and dates part 1 at the time of discussion (if necessary) with the Designated Officer (MGPS).
- 6.126 This part of the form also contains space for the predicted timescale of the work and the signature of the Designated Officer (MGPS) (if appropriate).
- 6.127 Although initial discussions with the Designated Officer (MGPS) take place at the time the Authorised Person (MGPS) signs part 1, the Designated Officer (MGPS) will not be expected to sign part 1 until the day the work is to take place. This allows final consultation with the clinical/nursing staff and confirmation that the work is able to take place.
- 6.128 If work is to be carried out on BS 5682/BS EN 737-1 terminal units only, the statements “Terminal units have integral isolating valves” or “Terminal units are to BS 5682/BS EN 737-1” should be included in part 1 under “The following work is to be carried out”.
- 6.129 Wherever possible, drawing reference numbers should be identified on the permit. A copy of the relevant drawing should be attached to the permit.
- 6.130 Other permits in use should be referenced in part 1. These could include a “confined spaces permit” or permits associated with bacteria-filter changing issued by the infection control officer (see [Appendix D](#)).

Part 2

- 6.131 This is for the Competent Person (MGPS) to sign just before the work is due to start. The permit (yellow copy) is presented to the Competent Person (MGPS) who will read – questioning anything not understood – then sign part 2, accepting responsibility for the work and anyone working under their supervision.
- 6.132 It is important to ensure that the Competent Person (MGPS) is fully informed of, and conversant with, any special safety measures/procedures that may be in force during the work.
- 6.133 At this stage the permit (and its duplicates) are still in the permit book, but following signature of part 2 by the Competent Person (MGPS), the yellow copy of the permit should be placed in a

protective cover and given to the Competent Person (MGPS) for the duration of the work.

Part 3

- 6.134 The installation must be ready for examination by the Authorised Person (MGPS) at this stage. Part 3 is signed on completion of the work by the Competent Person (MGPS) including, where appropriate, any testing relevant to the work.
- 6.135 The Competent Person (MGPS) returns to the permit book and signs part 3 of the white copy (the yellow copy is in place in the book to allow transfer of text).
- 6.136 The Authorised Person (MGPS) should satisfy himself/herself that the work has been carried out as prescribed. This may be by actually witnessing the appropriate tests by the Competent Person (MGPS) or by examining the completed test record sheets. Part 3 of the permit should be filled in by the Competent Person (MGPS) to indicate a “pass” or “fail” status for each test performed in order to enable the Authorised Person (MGPS) to make an informed decision on the suitability of the system for use.
- 6.137 At this stage, failure of one or more tests will usually indicate that further work on the system will be required.

Part 4

- 6.138 This is completed by the Authorised Person (MGPS) when satisfied that the system may be taken back into use or, alternatively, that further work and hence permit cancellation are required.
- 6.139 If appropriate, the Authorised Person (MGPS) then informs the Designated Officer (MGPS) that the work is completed and that the MGPS is now ready for use.

Part 5

- 6.140 This section enables the Designated Officer (MGPS) to acknowledge the status of the system following the work. Normally, this will be an acceptance that the system is ready for use and an agreement to inform clinical/nursing colleagues of this fact. However, the section also allows for recognition that further work, involving an additional permit, may be necessary.
- 6.141 The yellow copy of the permit must be in the permit book at this stage to allow transfer of signatures.

- 6.142 The Authorised Person (MGPS) should remove any “do not use” or other prohibition labels and retain the book containing the completed white copy of the permit. The second (pink) completed copy of the permit should be given to the Quality Controller (MGPS). The Competent Person (MGPS) may retain the yellow copy.

Preparation and issue of permit-to-work – examples

- 6.143 These examples can be used as the basis for preparing MGPS operational policy procedures for permit-to-work system management.

High hazard work

Typical minimal work at high hazard

- 6.144 Minimal work might include a planned interruption of a medical gas supply to a single ward or department.

Typical maximal work at high hazard

- 6.145 Maximal work might include a major shut-down of a medical gas system to a whole hospital site.

Liaison before work

- 6.146 It is the duty of the Authorised Person (MGPS) to ensure that the Quality Controller (MGPS) and key personnel for every ward or department likely to be affected by the work are fully informed of the implications of the work in terms of responsibilities, possible disruption, contingencies, safety and timescale. It may be necessary to hold a site meeting to achieve these objectives.

Work protocol

- 6.147 The following protocol will cover most work at high hazard. Where circumstances dictate necessary deviation from the protocol, it is the duty of the Authorised Person (MGPS) to ensure that all personnel involved with the work are made aware of the situation.

(1) Two weeks before the planned interruption

- 6.148 The Authorised Person (MGPS) completes part 1 of the permit-to-work form and liaises in person with the Designated Officer(s) (MGPS) of the ward(s) or department(s) concerned. The Designated Officer(s) (MGPS) are made aware

that their signatures will be required on the agreed date on which the work is due to take place.

- 6.149 The requirement for portable cylinders or vacuum units is determined and confirmed, with details of the interruption, by a memorandum from Estates to the Designated Officer(s) (MGPS).
- 6.150 A copy of this memorandum is sent to the ward(s) or department(s) concerned.
- 6.151 A further memorandum requesting the services of the Quality Controller (MGPS) and detailing the requirements for portable cylinders is sent to pharmacy and the head porter respectively.
- 6.152 The Authorised Person (MGPS) arranges, through the portering, pharmacy and medical engineering departments (or a contract hire firm, if necessary), for portable cylinders and regulators.
- 6.153 The Authorised Person (MGPS) should advise the ward/department concerned so that they can arrange for the provision of any additional portable vacuum units.
- 6.154 The Authorised Person (MGPS) provides all details of the work to be carried out, including any other permits (for example hot works or entry into confined spaces).

(2) On the day of the work

- 6.155 Work shall only commence when the Designated Officer(s) (MGPS) for the ward(s) or department(s) is/are satisfied that no patients will be put at risk by the shut-down of the MGPS and has/have signed part 1 of the permit-to-work form.
- 6.156 The Authorised Person (MGPS) supervises isolation of the AVSU/LVA(s) by the Competent Person (MGPS), having confirmed isolation details on part 1 and the fourth sheet of the permit.
- 6.157 Once the system(s) has/have been isolated and depressurised, the Competent Person (MGPS) signs both part 2 and the fourth sheet of the permit-to-work form and then commences the work. He/she retains the yellow copy for the duration of the work, while the Authorised Person (MGPS) signs the fourth sheet and retains it in the permit book.
- 6.158 On completion of the work, the Competent Person (MGPS) contacts the Authorised Person (MGPS) so that the installation may be examined before testing.

(3) Engineering and pharmaceutical testing of the completed work

- 6.159 Depending on the extent of high hazard work, the Authorised Person (MGPS) determines and (if agreed in the contract) carries out, with the assistance of the Competent Person (MGPS), the necessary engineering tests and examination of the system(s) in accordance with this Health Technical Memorandum.

Note

Normal contract work will not involve the Authorised Person (MGPS) in either determining or actually carrying out the tests. However, good practice dictates that any opportunity to allow participation of the Authorised Person (MGPS) should be taken whenever possible.

- 6.160 On obtaining satisfactory test results, the Competent Person (MGPS) and Authorised Person (MGPS) sign part 3 of the permit, signifying that the work is ready for pharmaceutical testing.
- 6.161 On completion of the engineering tests and examination, the Quality Controller (MGPS), with the assistance of the Authorised Person (MGPS), carries out identity and quality tests on the system(s) in accordance with this Health Technical Memorandum.
- 6.162 On obtaining satisfactory results, both sign part 4 of the permit.

(4) Handing back the tested system on completion of work

- 6.163 The Designated Officer(s) (MGPS) accept(s) the system(s) back into service by signing part 5 of the permit and undertake(s) to inform his/her colleagues that the system is fit for use.

(5) Copies of permits

- 6.164 The Quality Controller (MGPS) receives the pink copy of the completed permit-to-work form from the Authorised Person (MGPS).
- 6.165 The Authorised Person (MGPS) retains the completed white (top) copy in the permit-to-work book together with the fourth sheet.
- 6.166 Photocopies of the white copy/fourth sheet may be issued to a Competent Person (MGPS) on request. Alternatively, he/she may retain the yellow copy.

Low hazard work

Typical minimal work at low hazard

- 6.167 Minimal work might include changing oil and filters on a compressed-air plant. (This does not require the signature of a Designated Officer (MGPS).)

Typical maximal work at low hazard

- 6.168 Maximal work might include the replacement of BS 5682/BS EN 737-1 terminal-unit seals in a whole department. (This requires the signature of a Designated Officer (MGPS).)

Liaison before work

- 6.169 Where work is pre-planned (for example annual servicing of terminal units), it will be possible for the Authorised Person (MGPS) to liaise with the appropriate nursing/clinical staff well before the work is to start. However, leaks on terminal units arising from faulty/damaged valves or seals often warrant that the work be carried out at short notice, because of the need for minimum disruption to patient care.
- 6.170 Work on plant which does not lead to disruption of supplies to clinical areas, for example filter or oil changes, will be pre-planned by the estates department and will not require the signature of a member of the nursing/clinical staff.

Work protocols

- 6.171 The following protocol will cover most work at low hazard. Where circumstances dictate necessary deviation from the protocol, it is the duty of the Authorised Person (MGPS) to ensure that all personnel involved with the work are made aware of the situation.

(1)(a) For quarterly terminal unit service visits – two weeks before the planned interruption

- 6.172 The Authorised Person (MGPS) completes part 1 of the permit-to-work form and liaises in person with the Designated Nursing Officer(s) (MGPS) of the ward(s) or department(s) concerned.
- 6.173 The Designated Nursing Officer(s) (MGPS) is/are made aware that their signatures will be required on the agreed date on which the work is due to take place.
- 6.174 The requirement for portable cylinders or vacuum units is determined and confirmed, with details of

the interruption, by a memorandum from Estates to the Designated Nursing Officer(s) (MGPS).

- 6.175 A copy of this memorandum is sent to all ward(s) or department(s) involved.
- 6.176 A further memorandum detailing the requirements for portable cylinders is sent to pharmacy and the head porter respectively.
- 6.177 The Authorised Person (MGPS) arranges, through the portering, pharmacy and medical engineering departments (or a contract hire firm, if necessary), for portable cylinders and regulators.
- 6.178 If more portable vacuum units are required, the wards/departments concerned should organise this.
- 6.179 The Authorised Person (MGPS) also provides all details of the work to be carried out on this part of the form.

(1)(b) For immediate work, for example repair to leaking terminal unit

- 6.180 If required, the Authorised Person (MGPS), in liaison with nursing/clinical staff, arranges a portable cylinder or vacuum unit so that the terminal unit can be taken out of service.
- 6.181 The Authorised Person (MGPS) completes the relevant section of part 1 of the permit-to-work form, providing all details of the work to be carried out.
- 6.182 The Authorised Person (MGPS) liaises with, and fully briefs, the senior duty nurse of the ward/department, who will then also sign part 1.
- 6.183 When satisfied with the extent of the work, the Competent Person (MGPS) signs part 2 and begins the work.
- 6.184 On completion of the work, the Competent Person (MGPS) contacts the Authorised Person (MGPS) for the installation to be examined and tested.

(1)(c) For work on central plant, for example compressor oil and filter change

- 6.185 The Authorised Person (MGPS) liaises with pharmacy/portering for additional labour, if necessary, and cylinders for use on the emergency reserve manifold.
- 6.186 The Authorised Person (MGPS) completes the relevant section of part 1 of the permit-to-work form, providing all details of the work to be carried out.

- 6.187 When satisfied with the extent of the work, the Competent Person (MGPS) signs part 2 and begins the work.

- 6.188 On completion of the work, the Competent Person (MGPS) contacts the Authorised Person (MGPS) for the installation to be examined.

(2) Engineering tests on completion of work

- 6.189 **Terminal units:** the Competent Person (MGPS), with the assistance of the Authorised Person (MGPS), if necessary, carries out flow, pressure drop and mechanical function tests on the serviced/repaired terminal unit(s). (Gas-specific probes can be used to confirm gas-specificity if required.) When satisfied with the test results, the Authorised Person (MGPS) signs part 4 of the permit, signifying that the system is ready for use.

- 6.190 **Plant:** equipment function tests, and any associated alarm/monitoring system tests, are made to the satisfaction of the Authorised Person (MGPS). When satisfied with the test results, the Authorised Person (MGPS) signs part 4 of the permit, signifying that the plant is ready for use.

(3) Handing back the tested system on completion of work

- 6.191 The senior duty nurse of the ward or department accepts the MGPS back into service by signing part 5 of the permit and undertakes to inform his/her colleagues that the system is ready for use.

(4) Copies of permits

- 6.192 The Quality Controller (MGPS) receives the completed pink copy of the permit-to-work form from the Authorised Person (MGPS).

Note

Many Quality Controllers (MGPS) do not keep permits, work dockets or other paperwork associated with low hazard work. However, if properly organised, permits constitute a comprehensive record of work carried out on the system, and copies should be kept.

- 6.193 The Authorised Person (MGPS) retains the completed white copy in the permit-to-work book. Photocopies of the white copy may be issued to a Competent Person (MGPS) on request, although they will normally only retain the yellow copy.

Handing back systems that will not be used immediately

6.194 It is possible to install and commission a new ward or department without the need for issuing a permit-to-work. However, connection of the new pipework into the existing system requires the use of a high hazard permit. Although it may be relatively easy to obtain the signature of a Designated Officer (MGPS) to allow the connection to proceed, it may be more difficult to obtain the same signature confirming handover of a system that may remain out of use for some time before patients are admitted to the area.

6.195 In such cases, consideration should be given to delaying final testing of the system until a more appropriate time. In the intervening period, the MGPS should be left filled with medical air as described in Chapter 15, Part A.

6.196 If this course of action is unacceptable, it may be necessary to repeat some of the tests before the system is used with patients. The Authorised Person (MGPS) should liaise with both the Quality Controller (MGPS) and the Designated Officer (MGPS) to establish a suitably documented handover procedure.

7 Training and communication

General

- 7.1 The Health and Safety at Work etc Act 1974 requires every employer to provide such information, instruction, training and supervision as is necessary to ensure, so far as is reasonably practicable, the health and safety at work of their employees.
- 7.2 The Act also places duties on employees to take reasonable care to cooperate with employers and not to interfere with or misuse anything provided for their safety.
- 7.3 It is essential, therefore, that personnel at all levels have a sound general knowledge of the principles and functions of MGPS.
- 7.4 No person should operate medical gas systems or equipment unless they are properly trained or supervised.
- 7.5 A training programme should be established for all staff responsible for MGPS.
- 7.6 All training should be recorded and reviewed regularly.
- 7.7 The Executive Manager should ensure that all estates/nursing/medical staff have received this training before using the MGPS and that refresher courses are arranged as detailed in **Table 1**. Induction training for any personnel who will be working with medical gases should include the essential elements of medical gas safety and emergency actions.
- 7.8 All Authorised and Competent Persons (MGPS) should have satisfactorily completed appropriate medical gas and first-aid training courses before they are appointed.
- 7.9 It is essential that all training courses include practical elements (for example brazing practice) for Competent Persons (MGPS) carrying out installation work, and terminal unit servicing for Competent Persons (MGPS) carrying out maintenance. MGPS compliance assessment and completion of MGPS permits by Authorised Persons (MGPS) should form part of all Authorised Person (MGPS) training courses. It is equally essential that documented assessments of practical competencies are made during the course.
- 7.10 This is particularly important for Competent Person (MGPS) training, since Authorised Persons (MGPS) employing BS EN ISO 9001/BS EN ISO 13485 installation companies are not expected to test such competencies.
- 7.11 However, as Authorised Persons (MGPS) are expected to satisfy themselves of the competence of any employed or contracted staff, it will be expected that all prospective Competent Persons (MGPS) are able to offer documentary evidence of training in basic competencies and any supplementary training and relevant experience. Contractors and/or their staff unable or unwilling to provide such evidence should not be allowed to work on medical gas systems.
- 7.12 It is essential that all courses are relevant to today's needs and are delivered to an appropriate and consistent standard. Courses demonstrating elements of quality control in delivery and assessment procedures are therefore recommended.
- 7.13 Accreditation of courses is currently under review, but MGPS courses offering accreditation by Edexcel and CGLI are available from specialist organisations.

Familiarity with systems and equipment

- 7.14 Personnel should be familiar with those specific systems and/or equipment for which they will be responsible. This familiarisation process will be additional to the more generic training provided at dedicated centres, or when attending training courses at other hospitals, both of which may use different types of equipment and/or system configurations.
- 7.15 Familiarisation with central plant operation is essential; in particular, those procedures ensuring

continuity of supply in the event of failure of the plant.

- 7.16 It is essential that time is allocated for this familiarisation process, and personnel should not be appointed as Authorising Engineers (MGPS), Authorised Persons (MGPS), Competent Persons (MGPS), Designated Officers (MGPS) or Designated Porters (MGPS) without sufficient experience and familiarisation with their particular installations and/or equipment.

Refresher training and reassessment

- 7.17 Retraining and reassessment should be carried out at regular intervals. Table 1 shows recommended intervals, but there will be occasions when additional training may be required (for example response to changes in technology or guidance, equipment failures, and incidents involving risks to staff/patients).

Table 1 Refresher training and reassessment schedule for personnel working with medical gas systems

Personnel	Retraining	Re-assessment
Authorising Engineer	Every 3 years	Every 3 years
Authorised Person	Every 3 years	Every 3 years
Competent Person	Every 3 years	Every 3 years
Designated Medical Officer	Every 3 years	Every 3 years
Designated Nursing Officer	Every 3 years	Every 3 years
Quality Controller	Every 5 years	Every 5 years
Designated Porter	Every year	Every year
General Nursing staff	Every year	N/A (See note)

Note

A medical equipment “driving licence” for nursing staff may be introduced during the lifetime of this Health Technical Memorandum. Training and competence requirements are likely to be related directly to the terms of such a licence.

- 7.18 The recommendation for appointment or re-appointment as an Authorised Person (MGPS) should be made by an Authorising Engineer (MGPS).
- 7.19 The Quality Controller (MGPS) should also receive specific training covering the responsibilities and duties which he/she will be required to carry out.

- 7.20 It may be appropriate for the Quality Controller (MGPS) to attend part or all of the training courses for Authorised Persons (MGPS), but training courses dedicated to medical gas QC testing are provided by some specialist organisations and at least one UK university.
- 7.21 The medical and nursing staff who will use the MGPS should be trained in the practical use of the system (including the safe use of basic equipment such as flowmeters and suction controllers), safety procedures and actions in the event of emergencies.
- 7.22 Designated Officers (MGPS) will require more detailed training in specific areas such as emergency procedures and use of the permit-to-work system.

Training records

- 7.23 Training records should be kept for all staff undertaking MGPS training. It is the responsibility of individuals to maintain copies of their own training records, but there may be other requirements to be met; for example, in the case of Authorising Engineers (MGPS), records will be kept by the Institute of Healthcare Engineering and Estate Management (IHEEM).
- 7.24 Authorised Person (MGPS) records will be kept by both the Authorised Person (MGPS) and the Authorising Engineer (MGPS).
- 7.25 Competent Persons (MGPS) directly employed by the trust will be assessed by the Authorised Person (MGPS) as competent to perform the required work, and records of appropriate training and experience will be kept by the Authorised Person (MGPS) and the Competent Person (MGPS).
- 7.26 Contractors providing Competent Person (MGPS) services will be expected to maintain relevant records and produce these on request by the Authorising Engineer (MGPS) or Authorised Person (MGPS).

Limitation of activities

- 7.27 Evidence of experience and training will be used to determine both the limits of authorisation of an Authorised Person (MGPS) and the scope of work carried out by a Competent Person (MGPS). For example, following an assessment exercise, an Authorising Engineer (MGPS) may decide that an Authorised Person (MGPS) is insufficiently experienced or familiar with an MGPS to write permits for high hazard work. In such a case, the Authorising Engineer (MGPS) will produce a

written statement to this effect and also make recommendations for further training and/or familiarisation.

- 7.28 Similarly, an Authorised Person (MGPS) may nominate a person as a Competent Person (MGPS) but with his/her scope of work limited to only, for example, electrical work on the MGPS.
- 7.29 Contractors offering Competent Person (MGPS) services may limit the extent of work performed by each employed Competent Person (MGPS). In its simplest form, this could be a division of labour into installation and maintenance teams. However, within these teams, the company could limit work in accordance with the experience level of the Competent Person (MGPS).
- 7.30 The training needs of estates staff not registered as Competent Persons (MGPS) but who carry out routine work on the MGPS (for example checking oil levels, filters and monitoring instrumentation) must not be ignored. Each should be suitably trained to perform this work safely and competently, such that the risk of gas supply interruption or contamination is minimised. Records of this training should be kept by the Authorised Person (MGPS).

Training course content and learning outcomes

- 7.31 Training course outline content and learning outcomes are presented below as a guide for providers. However, these should be regarded as the minimum inclusions in any training courses for the defined personnel.
- 7.32 Learning outcomes (what the trainee should be able to achieve on completion of the training) are directly related to job responsibilities.
- 7.33 During the lifetime of this Health Technical Memorandum, training course content and accreditation procedures will be defined more clearly by the Department of Health's Estates and Facilities Division.
- 7.34 Further guidance on appointment and registration of Authorising Engineers (MGPS) and Authorised Persons (MGPS) will also be published, and an Advanced Modern Apprenticeship Scheme for estates departments will also be introduced.

Authorising Engineer (MGPS)

Course content

- a. MGPS audit, including the permit-to-work system and report production;
- b. monitoring of training programmes and identification of training needs;
- c. Authorised Person (MGPS) assessment procedures and the authorising process;
- d. updating on Standards/technology/procedures;
- e. validation procedures and requirements;
- f. monitoring procedures for MGPS operational policy.

Learning outcomes

7.35 The ability to:

- a. make recommendations to trust/PFI/FM company senior management on the number of Authorised Persons (MGPS) needed to provide Authorised Person services;
- b. ensure that all (senior) Authorised Persons (MGPS) have satisfactorily completed an appropriate training course before appointment;
- c. ensure that all (senior) Authorised Persons (MGPS) are re-assessed every three years and have attended a refresher or other suitable training course before such re-assessment;
- d. conduct an annual audit and review of the management systems of the MGPS, including the permit-to-work system;
- e. maintain such records as are necessary for the safe and efficient running of each site;
- f. maintain a register of all Authorised Persons (MGPS) and healthcare sites within their area of responsibility;
- g. provide Authorised Persons (MGPS) and other interested parties with technical support and advice;
- h. ensure that Authorised Persons (MGPS) are acting on information and guidance from the Department of Health's Estates and Facilities Division and/or other bodies pertinent to the operation and safety of the MGPS;
- j. monitor the implementation of the MGPS operational policy and this Health Technical

Memorandum on each site and to ensure that annual review takes place.

Authorised Person

Course content

- a. statutory obligations and safe system operation;
- b. MGPS design and installation requirements;
- c. structure and management of the permit-to-work system;
- d. supervision of the Competent Person's (MGPS) work and management of MGPS contracts;
- e. MGPS equipment performance requirements (plant and pipeline);
- f. technical reporting including system capacities/limitations, upgrading requirements/equipment replacement, system compliance;
- g. MGPS documentation;
- h. emergency procedures;
- j. MGPS operational policy preparation, implementation and monitoring;
- k. MGPS testing and quality control requirements.
- h. keep up-to-date records of MGPS plant and pipelines, plant and system histories, certificates of insurance, test records and commissioning/repair data for inspection by the Authorising Engineer (MGPS);
- j. control the storage, maintenance, issue and usage of any MGPS test or emergency supply equipment;
- k. follow defined incident and accident reporting procedures;
- m. control the storage, coding and issue of keys for the operation of MGPS;
- n. ensure that all AVSUs and LVAs are subject to a labelling system;
- p. organise such training as is necessary for staff involved with the MGPS;
- q. advise users on the safe use of an MGPS and associated equipment;
- r. advise users on MGPS deficiencies and the likely effects of proposed equipment connection;
- s. ensure that all MGPS plant is prepared for statutory inspections by a Competent Person (PSSR);
- t. retain copies of all as-fitted and other MGPS drawings and written schemes of examination as prepared by the Competent Person (MGPS);
- u. ensure that MGPS plant and pipelines are suitably signed to indicate gas type and flow direction, safety hazards, precautions and (in the case of bacteria filters) a safe filter changing procedure;
- v. ensure the safe and secure accommodation of MGPS plant and manifold systems and, where appropriate, emergency supplies and cylinders;
- x. manage the MGPS permit-to-work system in liaison with other disciplines, and issue, cancel and retain records of permits as required.

Learning outcomes

7.36 The ability to:

- a. ensure that the guidance in this Health Technical Memorandum is implemented by all staff working on or with the MGPS;
- b. prepare or commission a compliance survey of the MGPS, and associated risk assessment and proposals for any consequent remedial actions;
- c. ensure current quality assurance registration of MGPS contractors;
- d. ensure contractors provide appropriate method statements, risk assessments and health and safety statements;
- e. prepare risk assessments, method statements and health and safety statements for MGPS work carried out by directly employed Competent Persons (MGPS);
- f. assess and record the competence levels of directly employed Competent Persons (MGPS);
- g. maintain a register of directly employed Competent Persons (MGPS);

7.37 Chapter 4 lists additional specific duties for Authorised Persons (MGPS) who manage sites with cryogenic (VIE) systems.

Competent Person (MGPS)

7.38 For Competent Persons (MGPS), to offer skills in all areas is unusual. However, if this is to be the case, all elements of the course contents listed below will have to be covered by the training

provider. It is essential that training providers offer training in, and assessment of, the practical skills needed to carry out the work of a Competent Person (MGPS).

Course content

- a. plant and system theory;
- b. basic fault-finding, including responding to routine plant-monitoring system indications;
- c. the MGPS permit-to-work system;
- d. installation principles and practices;
- e. pipe jointing procedures and safety (including practical jointing work);
- f. MGPS testing (including practical work);
- g. emergency procedures;
- h. preparation of method statements, health and safety statements and policies;
- j. reading and revising pipeline drawings (including as-fitted drawings);
- k. plant and system maintenance procedures.

Learning outcomes

7.39 The ability to:

- a. sign the MGPS permit-to-work and acknowledge responsibility for the work;
- b. obtain and understand instructions on work to be done;
- c. carry out the work in accordance with this Health Technical Memorandum, including the final connection, under direct supervision of the Authorised Person (MGPS);
- d. carry out the system tests outlined in this Health Technical Memorandum on completed work, with the appropriate calibrated test equipment;
- e. sign the permit, declaring that the work is completed as indicated on the permit;
- f. work with due care for personal and others' safety.

Note

“The work” will encompass installation, maintenance, extension, modification, repair and testing of systems.

7.40 Course content considered suitable for contractors' Competent Persons (MGPS) engaged in installation work is presented below.

Course introduction

- course purpose and description;
- Health Technical Memorandum 02 introduction.

Introduction to medical gas systems

- medical gases in hospitals – their properties and safety;
- medical gas system structure;
- medical air plant;
- vacuum plant;
- manifolds;
- VIE systems;
- emergency supplies.

Application of gas systems in:

- hospitals;
- clinics;
- dental surgeries/department;
- laboratories.

Medical air systems

- types of compressors used;
- installation requirements;
- alarm requirements.

Other medical gas sources

- manifold systems;
- cryogenic liquid cylinders;
- bulk cryogenic (VIE) systems;
- alarm requirements.

Medical vacuum pumps

- types of pump;
- installation requirements;
- alarm requirements.

Valve types and locations/terminal units

- plant isolation valves;
- AVSUs – use of blanking plates;
- riser valves;
- line valve assemblies;
- NIST connectors;
- terminal unit structure (first- and second-fix assembly);
- ensuring gas specificity.

Alarm systems

- local alarms;
- central alarms;
- pressure switches/sensors;
- installation and testing.

The permit-to-work system

- the MGPS permit-to-work system;
- safe isolation under a permit;
- emergency isolation;
- emergency repairs;
- other work controlled by a permit.

Joining techniques

Brazing requirements:

- brazing procedure specifications;
- types of filler material allowed;
- joint preparation;
- adjustment of torch and heat;
- quality control inspections.

Mechanical/cold joining:

- joining procedure specifications;
- joint preparation;
- quality control inspections.

Joining practice and testing

- practical brazing practice, including horizontal and vertical joints;
- mechanical joining practice;
- inspection of joints/quality control practice.

Contractor testing requirements

- pressure/leak testing (including carcass, system, valves etc);
- cross-connection testing;
- alarm system testing;
- purging – odour and particulate tests;
- preparation of systems for pharmaceutical testing;
- documentation/test records.

7.41 Practical compliance assessments must be supplemented with a final written examination.

Quality Controller (MGPS)

Course content

- a. medical gas production and quality control, chemical and physical properties, and safety requirements;
- b. medical gas systems – pipework and plant structure and basic principles of operation (including alarm systems and reserve supplies);
- c. the permit-to-work system and the role of the Quality Controller (MGPS);
- d. principles and procedures of MGPS QC testing, including test equipment principles, calibration etc (this will include practical use of equipment and live system testing);
- e. problem systems and coping with emergencies;
- f. record-keeping;
- g. legal requirements and regulations (for example Health & Safety at Work etc Act 1974, COSHH);
- h. cylinder management.

Learning outcomes

7.42 The Quality Controller (MGPS) should be able to demonstrate knowledge and understanding by being able to:

- a. describe MGPS structure and components, and the statutory and guidance requirements for its safe, efficient operation and management (for example COSHH and the Health and Safety at Work etc Act 1974);
- b. define chemical and physical properties of medical gases;

- c. define principles of testing for contaminants (including moisture) in gases and the use of gas-testing analytical equipment, including maintenance and calibration;
- d. maintain and calibrate gas-testing analytical equipment (including “in the field” calibration);
- e. test a medical gas system to current quality control standards and produce a report on the suitability of the system for supplying medical gases;
- f. identify the origins and likely causes of MGPS contamination;
- g. complete relevant sections of an MGPS permit-to-work;
- h. advise on the extent of QC testing pertinent to engineering work on an MGPS;
- j. advise on the safe use and management of medical gases and medical gas cylinders;
- k. keep and analyse records of liquid and compressed gas usage to ensure maximum efficiency of purchase (optional).

Designated Nursing Officer/Designated Medical Officer (MGPS)

7.43 Topics (a) to (h) in the course content below are intended for all nursing/medical staff working with medical gas systems.

7.44 Topics (j) to (m) are options for those assuming the role of Designated Officer (MGPS) or those who may have specific responsibilities in the topic areas.

Course content

- a. MGPS and cylinder safety;
- b. MGPS basic principles;
- c. the permit-to-work system and supply system interruption procedures;
- d. MGPS equipment purchase and system capacity considerations;
- e. fault reporting;
- f. emergency situations, including alarm system indications and emergency isolation procedures;
- g. MGPS operational policy;
- h. gas conservation;
- j. contingency planning;

- k. permit-to-work;
- m. anaesthetic gas scavenging systems (AGSS).

Learning outcomes

7.45 The ability to:

- a. define a medical gas, especially in the context of its role as a medicine;
- b. list medical gases in common use;
- c. describe the dangers of medical gases and take appropriate precautions to ensure patient and staff safety during their use;
- d. identify a range of medical gas cylinders by size, valve type and colour-coding;
- e. handle, move and, where relevant, store medical gas cylinders safely;
- f. prepare a medical gas cylinder for use, connect it to a piece of medical equipment and, when empty, take the cylinder out of use, with due regard to any relevant local labelling requirements;
- g. identify a faulty cylinder and take appropriate action;
- h. identify medical gas pipeline terminal units and flexible, colour-coded hoses;
- j. use safely and carefully terminal units, their probes and flexible hose assemblies;
- k. prevent pollution of piped medical vacuum systems;
- m. cope with and prevent medical gas emergencies by:
 - (i) distinguishing between “normal” and “fault” medical gas alarm indications;
 - (ii) coping with damage to terminal units and serious gas leaks;
 - (iii) using an AVSU for emergency isolation of a medical gas supply;
 - (iv) reacting correctly in the event of fire;
 - (v) reacting correctly in the event of total electricity supply failure;
 - (vi) reacting correctly in the event of total or partial gas supply failure;
 - (vii) identifying a contaminated gas supply;

- n. in addition to the skills identified in (m) above, plan effective remedial actions to deal with shut-down or failure of medical gas systems in order to maintain patient safety;
- p. permit isolation of a medical gas system in accordance with the MGPS permit-to-work system;
- q. accept an MGPS back into service following maintenance, repair or modification by correct use of the MGPS permit-to-work system;
- r. use and maintain effectively an active AGSS in an operating environment;
- s. identify fault conditions on an active AGSS and take appropriate remedial action to ensure operating staff and patient safety.
- e. the permit-to-work system to be covered only in respect of its use in the protection of patients and prevention of unauthorised work on the medical gas system;
- f. pipeline connected equipment – an overview.

Note 1

The action to be taken in the event of a fault or emergency should be referred to in terms of local requirements for reporting the situation to estates or line management.

Note 2

Manual-handling training should supplement the above training and should encompass the handling and movement of compressed gas cylinders.

Designated Porter (MGPS)

Course content

Gas properties and safety:

- a. the hazards of compressed and cryogenic gases;
- b. cylinder colours and labelling;
- c. actions on finding defective cylinders;
- d. operation of cylinder valves;
- e. cylinder storage and handling (medical gas/pathology gas stores);
- f. preparation of cylinders for use;
- g. selection of appropriate equipment and its connection and disconnection to/from cylinders respectively.

Medical gas plant and systems:

- a. a general introduction to piped medical gas systems and safety including warnings on pressure, use of isolating valves, fire precautions etc;
- b. a general introduction to plant that portering staff may be involved with when changing cylinders, that is, cryogenic plant, compressed-air systems and general medical gas manifolds;
- c. operation of emergency reserve supplies to medical gas systems;
- d. alarm systems, and actions to be taken on alarm initiation;

Learning outcomes

7.46 The ability to:

- a. list the properties and hazards of a range of medical and pathology gases;
- b. identify a range of medical gas cylinders by colour code, size and other labelling, and select cylinders in accordance with the needs of clinical/medical/engineering staff;
- c. identify and describe the major components of pressurised gas systems and, in particular, a hospital MGPS;
- d. handle and transport pressurised gas cylinders safely;
- e. identify a range of patient-connected equipment requiring pipeline and/or cylinder supplies of gas;
- f. connect and disconnect safely pressurised gas cylinders from plant, manifolds and user equipment;
- g. respond to pressurised system alarms, hazards and emergencies, and observe local reporting procedures;
- h. replenish and operate (where required) emergency reserve supply systems in accordance with local estates directives.

Training of project managers, consulting engineers, design engineers and contract supervising officers

- 7.47 Medical gas systems are specialised services requiring considerable expertise in design, installation, validation and verification, if expensive and/or potentially dangerous situations are to be avoided.
- 7.48 It is essential that all personnel involved in these aspects of MGPS are able to verify to potential clients competence in the application of the principles described in this Health Technical Memorandum.
- 7.49 Attendance on specialist training courses (for example MGPS design, the management of an MGPS, and validation and verification techniques) should be considered an essential part of MGPS experience. Clients are strongly advised to seek evidence of such experience.

Requirements for appointment of Authorising Engineers (MGPS) and Authorised and Competent Persons (MGPS)

Authorising Engineer (MGPS)

- 7.50 An Authorising Engineer will be either:
- a chartered engineer in an appropriate engineering discipline; or
 - have sufficient engineering and pharmaceutical knowledge and be qualified to the level equivalent to incorporated engineer.
- 7.51 The Authorising Engineer will:
- have attended an accredited Authorising Engineer (MGPS) training course specific to the needs of the role (described above);
 - have attended an accredited Authorised Person (MGPS) course within the three years before applying for appointment as Authorising Engineer (MGPS);
 - produce signed evidence of familiarisation with the MGPS for which they will assume responsibility;
 - provide documentary evidence of formal qualifications and experience including records of continuing professional development (CPD) attendance;

- by means of a formal interview, satisfy the appointing body of his/her ability to perform the role safely, conscientiously and effectively.

Authorised Person (MGPS)

7.52 The Authorised Person will:

- possess a minimum of three years' relevant professional experience;
- be qualified to the level of Higher National Certificate in an electrical or mechanical engineering discipline.

7.53 The Authorised Person will:

- have attended an accredited Authorised Person (MGPS) course within the three years before applying for appointment;
- possess an adequate knowledge of health and safety aspects of MGPS plant and components, this Health Technical Memorandum, and other guidance and rules and regulations that are applicable to the systems and installations for which the appointment is sought;
- be technically competent to carry out routine and emergency operating procedures, being able to act in an emergency to make plant and systems safe and provide alternative supplies;
- provide documentary evidence of formal qualifications and experience, including records of CPD attendance;
- by means of a formal interview, satisfy the Authorising Engineer (MGPS) of his/her familiarisation with the MGPS for which they will assume responsibility and his/her ability to perform the role safely, conscientiously and effectively;
- have adequate knowledge of, and within the last three years have successfully completed a course in, emergency first-aid training.

Competent Person (MGPS)

7.54 The Competent Person (MGPS) will:

- have completed relevant modules of the Advanced Modern Apprenticeship Scheme or possess recognised formal electrical/mechanical qualifications (for example City & Guilds);
- possess a minimum of three years' relevant experience.

7.55 He/she will also:

- have attended an accredited Competent Person (MGPS) course within the three years before applying for appointment as Competent Person (MGPS);
- by means of a formal interview, have satisfied the appointing Authorised Person (MGPS) of his/her familiarisation with the MGPS on which they will work and his/her ability to perform the role safely, conscientiously and effectively.

Note

For contractor's staff, the Competent Person (MGPS)'s line manager (or other suitably trained and experienced person within the organisation) will carry out this interview and make the assessment as to suitability for the post.

Requirements for appointment of Quality Controllers (MGPS)

Criteria for appointment as a Quality Controller (MGPS)

- 7.56 Only individuals who have been appointed to the Quality Controller (MGPS) register may act as Quality Controller (MGPS).
- 7.57 Appointments to the Quality Controller (MGPS) register will be made **only** by regional quality control pharmacists.
- 7.58 Inclusion on the register will normally be sufficient to qualify an individual to act as Quality Controller (MGPS) for any hospital trust. However, the trust's chief pharmacist may exercise the option to specify, or otherwise limit, those registered as Quality Controller (MGPS) who may operate on their site.
- 7.59 The Quality Controller (MGPS) will:
- a. be a graduate who is eligible for membership of the Royal Pharmaceutical Society of Great Britain (RPSGB), the Royal Society of Chemistry (RSC) or Institute of Biology;
 - b. have successfully completed an accredited training course for QC testing of medical gases and piped medical gas systems;
 - c. have had extensive practical experience of QC testing of medical gases and piped medical gas systems;

- d. be familiar with the requirements of this Health Technical Memorandum;
- e. be named on the Quality Controller (MGPS) register maintained by the NHS Pharmaceutical Quality Assurance Committee; and
- f. undertake regular CPD in medical gases and MGPS. This would normally involve attending a refresher course at least every five years.

Transitional arrangements

7.60 The following transitional arrangements should apply, at the discretion of the regional quality control pharmacist:

- a. individuals who are not eligible for membership of the RPSGB, RSC or the Institute of Biology, having extensive practical experience of QC testing of medical gases and piped medical gas systems in the two years preceding publication of this Health Technical Memorandum, and who meet the other criteria above, may be appointed to the Quality Controller (MGPS) register and may continue to act as Quality Controller (MGPS);
- b. individuals with extensive practical experience of QC testing of medical gases and piped medical gas systems in the two years preceding publication of this Health Technical Memorandum and acting as Quality Controller (MGPS) at the time of publication, but who have not successfully completed an accredited course for QC testing of medical gases and piped medical gas systems, may continue to act as Quality Controller (MGPS) for a period of up to two years from the date of publication provided they undergo an accredited course within that period. If they do not successfully complete the course within this period they may be removed from the Quality Controller (MGPS) register.

Requirements for appointment of Designated Medical and Nursing Officers (MGPS)

- 7.61 Decisions on appointment to these functions should be carried out at local level, based on experience and possession of the basic skills outlined above. It is not possible in this Health Technical Memorandum to dictate whether local circumstances lead to appointment of Designated Nursing Officers, rather than Designated Medical

Officers, or a combination of both roles, to carry out the functions required of them in this Health Technical Memorandum under the MGPS permit-to-work system.

- 7.62 It is recommended that such appointments are discussed with the Authorised Person (MGPS) to arrive at a structure which is workable in routine and emergency situations.
- 7.63 It is essential that persons nominated into these roles are given training in accordance with the recommendations in this Health Technical Memorandum and attend refresher courses regularly.
- 7.64 Whatever decisions are taken, these should be documented in the MGPS operational policy and the list of nominated persons kept up-to-date.

Requirements for appointment of Designated Porters (MGPS)

- 7.65 Given the wide variation in line management responsibilities for staff carrying out duties as Designated Porters (MGPS), it is not possible to prescribe an appointment procedure other than having fulfilled the basic requirement of successful completion of the training recommended in this Health Technical Memorandum.
- 7.66 Local circumstances may demand additional training and experience if, for example, the Designated Porter (MGPS) is to work in a specified department or with particular types of equipment or gases.
- 7.67 Whatever route to appointment is chosen, care must be taken to ensure that no Designated Porter (MGPS) works with medical gases unless properly trained or supervised.

Independence of roles

- 7.68 It is feasible that any one person could be suitably qualified and experienced to act in two or more of the above roles.
- 7.69 However, in the interests of patient safety, it is essential that independence of functional responsibilities is maintained wherever possible.
- 7.70 For example, it is not acceptable that a person acting as a Quality Controller (MGPS) also acts as Authorised Person (MGPS) and/or Competent Person (MGPS) for the same job.

- 7.71 Similarly, an Authorising Engineer (MGPS) who will also be qualified as an Authorised Person (MGPS) should not carry out work as an Authorised Person (MGPS) which he/she then self-validates.

- 7.72 It is particularly important that commercial/financial interests are not allowed to influence this independence.

Communications

- 7.73 All staff who are involved in the use, installation or maintenance of MGPS should be aware of the MGPS operational policy and their specific responsibilities defined within it.
- 7.74 The MGPS operational policy should set out the means of communication between the various key personnel. It should, for example, define those departments that need to be informed of work on the MGPS, the personnel to be notified, and whether such information is to be verbal or in writing.
- 7.75 Lines of communication during emergencies and outside normal working hours are particularly important, and should be clearly documented in the policy.
- 7.76 It is essential that all details of responsible personnel and communication links presented in the MGPS operational policy are kept up-to-date. It will be the responsibility of the person heading the annual policy review (usually the (Coordinating) Authorised Person (MGPS)) to ensure that such information is communicated to all relevant personnel as quickly as possible.
- 7.77 It is recommended that a medical gas committee be established to oversee the general operation and management of the MGPS, and all facets of the MGPS operational policy including the policy review.
- 7.78 The committee, meeting at least annually, should be chaired by the (Coordinating) Authorised Person (MGPS), and report to the chief executive/general manager.

- 7.79 Constitution of the committee will depend on local circumstances, but should include, as a minimum, representatives from Estates, user departments, pharmacy and health and safety.
- 7.80 Other personnel can be invited to attend meetings, depending on particular needs (for example purchase of new MGPS equipment).

8 Cylinder management

Introduction

- 8.1 Medical gases are medicines and, as such, it is recommended that, regardless of operational infrastructure, the chief pharmacist should take an active role in the management of medical gas cylinders. It is essential that risk assessments are carried out as part of the cylinder management process (see [paragraphs 3.50–3.52](#)).
- 8.2 Sound cylinder management is important for the following reasons:
- it is particularly important that documentation needed to establish conformity of identity and quality with Ph. Eur. requirements is retained for possible inspection;
 - stock control issues are important in maintaining adequacy and continuity of supply;
 - improper methods of cylinder storage may give rise to serious health and safety issues.

Classification of gases by physical type

Permanent gases

- 8.3 These are gases that remain in the gaseous state in the cylinders at normal temperatures. The volume of the contents of the cylinder is directly related to the pressure of the gas; for example, at a quarter of the filled pressure, the cylinder is a quarter full. Such gases include oxygen and medical air.

Liquefiable gases

- 8.4 These are gases that are supplied as a liquid at normal temperatures (for example nitrous oxide and carbon dioxide) or gases supplied as a liquid at a cryogenic temperature, that is, below -40°C (for example liquid nitrogen and liquid oxygen).

Notes

The pressure of the gas stays fairly constant as the liquid is vaporised and only falls (often dramatically) when the cylinder is nearly empty.

Accurate measurement of cylinder contents is possible only by weighing the whole and deducting from it the tare weight of the cylinder (usually stamped on the cylinder shoulder).

Classification of gas cylinders

- 8.5 In this document, gas cylinders are classified into two main categories – medical and non-medical. Cylinders from these two categories must never be mixed, either in storage or in use.
- 8.6 Gas cylinders are subdivided into groups, depending on the major risk associated with the cylinder contents as follows:
- a. group 1 – flammable;
 - b. group 2 – oxidising;
 - c. group 3 – toxic or corrosive (the contents may also be flammable or oxidising);
 - d. group 4 – others (including inert gases).

The most common gases, grouped as above, likely to be used in health buildings are shown in [Table 2](#).

Labelling/marketing of cylinders

- 8.7 Cylinders should be colour-coded and marked in accordance with BS EN ISO 407:2004, the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2004, and European Directive 2004/27/EC. Each cylinder should have:
- a. a batch label to include a unique batch number, filling branch code, cylinder code and product, filling date and expiry date;
 - b. a product identification label which includes:

Table 2 Classification of gas cylinders

Group classification of gas cylinder contents	Medical gases	Non-medical gases
1 Flammable (red diamond on label)		• Acetylene • LPG (for example propane, butane) • STG (synthetic town gas) • Methane • Natural gas • Hydrogen
2 Oxidising and/or supports combustion (yellow diamond on label)	• Oxygen • Nitrous oxide • Oxygen/nitrous oxide • Oxygen/carbon dioxide • Oxygen/helium mixtures	• Oxygen • Nitrous oxide • Oxygen/nitrous oxide mixtures
3 Toxic and corrosive		
3.1 Toxic and/or corrosive and flammable		• Ammonia • Ethylene oxide (C_2H_4O) • Carbon monoxide • Ethylene oxide/carbon dioxide mixtures >6% C_2H_4O
3.2 Toxic and/or corrosive and oxidising		• Nitric oxide mixtures • Sulphur dioxide • Chlorine
3.3 Toxic and/or corrosive only		• Ethylene oxide/halocarbon mixtures <15% C_2H_4O (certain conditions only) • Ethylene oxide/carbon dioxide mixtures <6% C_2H_4O
4 Others including inert, but excluding toxic or corrosive (green diamond on label)	• Carbon dioxide • Helium • Medical • Nitric oxide 1000 vpm (volume parts per million) in nitrogen	• Compressed air • Carbon dioxide • Nitrogen • Argon • Helium • Halocarbon • Refrigerants

- (i) the product licence number;
- (ii) the name and chemical symbol of the gas or gas mixture contained in the cylinder. Additionally, in the case of gas mixtures, the proportion of constituent gases should be shown;
- (iii) a hazard warning sign;
- (iv) a substance identification number;
- (v) specific product and cylinder handling precautions;
- (vi) particular instructions to the user where necessary;
- (vii) safety information;

- c. a serial number;
- d. test mark, year and quarter of test.

8.8 Cylinders, pressure-reducing regulators and pressure gauges should be conspicuously marked “use no oil, grease or hand creams etc” or with the appropriate symbol. Cylinder yokes, pressure-reducing regulators and pressure gauges should be clearly and indelibly marked with the designation of the gas or gas mixture for which they are intended. BS EN ISO 407:2004 may be used as guidance.

8.9 Pressure gauges should be in accordance with BS EN 837-1:1998, with the appropriate standard for the particular type of medical equipment or to BS 4272-3:1989, as appropriate.

Cylinder colour codes

- 8.10 Cylinder colours are changing. See **Figure 3** for new cylinder colour codes.

Cylinder sizing and naming

- 8.11 New types of cylinders and sizes have been introduced and are shown in **Figure 3**.

Medical gas cylinder valve types

- 8.12 There are four basic valve types: bull-nose, hand-wheel, star and pin-index. The latter may be configured as either top/side spindle or knurled-knob (top) operated.
- 8.13 Bull-nose valves are used on larger cylinders: for example F, G and J. Gas connection is made between the spherical end (bull-nose) of the pipeline or regulator and the conical seat of the valve outlet. The seal is either by direct metal-to-metal contact between the bull-nose and cone (uncommon nowadays) or by an O-ring on the bull-nose.
- 8.14 The hand-wheel valve is used on F, G and J sizes of medical nitrous oxide, VF and LF sizes of carbon dioxide, and many pathology and industrial gas cylinders. A flat sealing washer (a Bodok seal) fits between the cylinder connector and valve. The cylinder is usually provided with a metal valve-protection guard and the gas outlet is fitted with a plastic or metal blanking cap. Plastic caps should be discarded before use, but metal screw-on valve covers should be retained and replaced before the empty cylinder is returned to the supplier. If fitted, the valve guard should not be removed.
- 8.15 The star valve combines a regulator and valve as a single unit. They are operated by a single hand-wheel and are fitted with a variety of outlets and, in the latest cylinder types, a differently formed hand-wheel. A range of output flow rates is also available. They are fitted to some sizes of medical air and oxygen cylinders. The latest, lightweight cylinders from gas suppliers are fitted with a combined valve (similar in construction to the star valve), regulator and flow control device. The cylinders will become available in a range of sizes during the life of this Health Technical Memorandum.
- 8.16 Pin-index valves (with a top spindle or knurled knob) are fitted to all E-size, and smaller, cylinders as well as to F- and G-size Entonox cylinders.

- 8.17 Pin-index valves with a side spindle (J-size oxygen and medical air for manifolds) should be operated with the correct key.

Safety notes

- a. The pin-index valve is not fitted to G-size medical air and oxygen cylinders, and it is still possible to interchange these gases in ward areas where G-size cylinders, attached to items of medical equipment, are in use.
- b. Knurled-knob valves fitted to smaller sizes of nitrous oxide cylinders should not be used to carry the cylinder, as it is possible for the valve to be opened accidentally, resulting in discharge of high-pressure expanding (and hence cooling) gas into the hand. Frostbite could result.
- c. During the period of introduction of this Health Technical Memorandum, new cylinder colour codes for medical and industrial cylinders are being introduced. Care must be taken to ensure that the new cylinders of industrial oxygen (at a pressure of 230 bar and having a black cylinder body and white shoulder akin to the “old” medical oxygen cylinder colour code) fitted with bull-nose valves are not inadvertently connected to medical equipment not designed to withstand this pressure (see **Figure 3**).

Cylinder safety – main principles

- 8.18 The main hazards associated with gas cylinders are:
- a. careless storage, handling, dropping or impact can cause physical or personal injury. These hazards should be minimised:
 - (i) by the correct design, siting and construction of cylinder storage areas;
 - (ii) by the provision of suitable storage and handling equipment; and
 - (iii) by the adoption of safe operating practices;
 - b. leakage of gas where the cylinder contents may be flammable, oxidising, asphyxiant, anaesthetic, toxic or a combination of these characteristics. In the event of leakage, gas may collect in a confined space and cause or contribute to a fire, explosion or health hazard.

Cylinder storage and handling

General

- 8.19** This section is concerned with the operational aspects of medical gas cylinders, including storage, handling and general safety, and applies also to the storage and handling of pathology and industrial cylinders. Attempts should be made to reduce manual handling of cylinders and excessive levels of storage.
- 8.20** Existing storage facilities should have been designed to comply with the recommendations of Health Technical Memorandum 16, Health Technical Memorandum 02 or earlier editions of Health Technical Memorandum 2022, as appropriate. Gas cylinders should have been stored in either a storeroom that is part of the health building or a separate, specially constructed building, both areas being used exclusively for medical gas cylinders. These stores will usually be satisfactory, provided that the ventilation is adequate.
- 8.21** The decanting and filling of medical gas cylinders is subject to the Pressure Systems Safety Regulations 2000 and the Health and Safety at Work etc Act 1974, and should not be carried out on a healthcare site.

Main stores

- 8.22** Guidance on the construction and use of these stores is given below, and this should be applied to all other storage areas where possible. Additional guidance on cylinder storage can be found in BCGA's (2005) Guidance Note GN2 – 'Guidance for the storage of transportable gas cylinders for industrial use'.

Ready-to-use stores

- 8.23** In some areas, it will be essential to hold small numbers of spare cylinders for immediate use for connection to anaesthetic machines and for sudden unanticipated demands. Such areas would include operating departments, Accident & Emergency departments, coronary care units, central delivery suites of maternity departments, special care baby units, critical care areas etc.
- 8.24** These stores should only be used for full cylinders, and all empty cylinders should be returned immediately to the main cylinder store. Attempts should be made to reduce the number of cylinders within the department.

- 8.25** The numbers of cylinders held should be kept to the minimum; a 24-hour supply should suffice for normal circumstances, although this may have to be increased for weekends, bank holidays etc and other operational reasons.
- 8.26** These cylinders should be kept in a specially designated room. This should comply as far as possible with the requirements for manifold rooms, but in any case should be well-ventilated and, where practicable, have at least one external wall to facilitate natural ventilation.
- 8.27** This designated room should be clearly labelled with the types of cylinder contained and "no smoking" warning signs.
- 8.28** No combustible material should be kept in the ready-to-use store. The general principles given in [paragraphs 8.48–8.84](#) should be followed where appropriate.
- 8.29** Cylinders should be stored in racks in accordance with BS EN ISO 407:2004.
- 8.30** Sufficient space should be provided for manoeuvring cylinders onto and off trolleys. Adequate means of securing large cylinders should be provided to prevent falling.
- 8.31** Small cylinders of oxygen/nitrous oxide mixtures should be kept horizontal and placed away from ventilation openings where practicable.
- 8.32** Cylinders connected to regulators may be returned to these stores. Check for leaks, close the cylinder valve, and vent the regulator contents before disconnecting it from the cylinder.
- 8.33** A good stock of cylinder keys should be kept in/near the store.

Local storage (wards)

- 8.34** Cylinders of medical air/oxygen mounted on trolleys are used as emergency gas supplies in ward areas. Designated "parking" areas should be sought for these trolleys, and the area should be signed to indicate its purpose.
- 8.35** All staff should be made aware of the location and function of these cylinders.

Local storage (non-specific storage areas)

- 8.36** There are occasions when small storage areas are established in a corridor. These usually consist of a cylinder support system and a notice identifying the purpose of the cylinders.

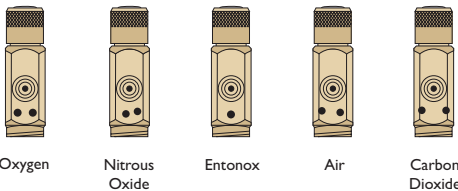
Figure 3



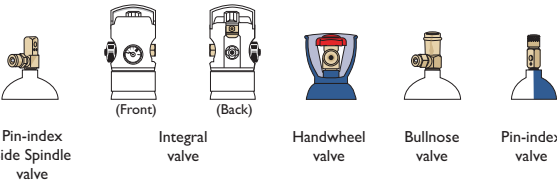
MEDICAL CYLINDER DATA

		Cylinder code	AZ	C	AD*	CD	DD ⁽¹⁾	PD	RD	ZD	D	E	AF ⁽¹⁾	DF ⁽¹⁾	F	LF	VF	AV	HX	ZX	G	AK	J	L
Medical Gas/ Medical Gas Mixture	Colour Code****	New valve Technology***			Integral valve	Integral valve	Integral valve		Integral valve	Integral valve				Integral valve					Integral valve	Integral valve				
OXYGEN		Contents (litres) Valve outlet pressure (bar (g)) Valve outlet connection	170 137 Pin-index	170 137 Pin-index	400 4 6mm firtree	460 4 Schraeder/ 6mm firtree	460 4 6mm firtree	300 137 Bullnose 5/8" BSP (f)	460 4 Schraeder/ 6mm firtree		340 137 Pin-index	680 137 Pin-index	1360 137 Bullnose 5/8" BSP (f)	1360 4 Schraeder/ 6mm firtree	1360 137 Bullnose 5/8" BSP (f)				2300 4 Schraeder/ 6mm firtree	3040 4 Schraeder/ 6mm firtree	3400 137 Bullnose 5/8" BSP (f)		6800 137 Pin-index (side spindle)	
NITROUS OXIDE		Contents (litres) Valve outlet pressure (bar (g)) Valve outlet connection	450 44 Pin-index	450 44 Pin-index							900 44 Pin-index	1800 44 Pin-index			3600 44 Handwheel 1 1/16" x 20tpi (m)						9000 44 Handwheel 1 1/16" x 20tpi (m)		18000 44 Handwheel 1 1/16" x 20tpi (m)	
ENTONOX (50% N ₂ O/50% O ₂)		Contents (litres) Valve outlet pressure (bar (g)) Valve outlet connection				440 4 Schraeder				794 4 Schraeder	500 137 Pin-index				2000 137 Pin-index (side spindle)				2200 4 Schraeder	3970 4 Schraeder	5000 137 Pin-index			
AIR		Contents (litres) Valve outlet pressure (bar (g)) Valve outlet connection	160 137 Pin-index									640 137 Pin-index			1280 137 Bullnose 5/8" BSP (f)						3200 137 Bullnose 5/8" BSP (f)		6400 137 Pin-index (side spindle)	
CARBON DIOXIDE		Contents (litres) Valve outlet pressure (bar (g))** Valve outlet connection		450 50 Pin-index								1800 50 Pin-index				3600 50 Handwheel 0.860" x 14tpi (m)	3600 50 Handwheel 0.860" x 14tpi (m)							
OXYGEN/CARBON DIOXIDE MIXTURE (95% O ₂ /5% CO ₂)		Contents (litres) Valve outlet pressure (bar (g)) Valve outlet connection													1360 137 Bullnose 5/8" BSP (f)						3400 137 Bullnose 5/8" BSP (f)		6800 137 Bullnose 5/8" BSP (f)	
HELIUM		Contents (litres) Valve outlet pressure (bar (g)) Valve outlet connection									300 137 Pin-index				1200 137 Bullnose 5/8" BSP (f)									
HELIUM/OXYGEN MIXTURE (79% He/21% O ₂)		Contents (litres) Valve outlet pressure (bar (g)) Valve outlet connection													1200 137 Bullnose 5/8" BSP (f)				1780 4 Schraeder/ 6mm firtree					
LUNG FUNCTION MIXTURES TYPE 1-4		Contents (litres) Valve outlet pressure (bar (g)) Valve outlet connection																1500 200 Side outlet Handwheel 5/8" BSP(LH)(f)			6000 200 Side outlet Handwheel 5/8" BSP(LH)(f)			
CARBON DIOXIDE/OXYGEN MEDICAL GAS MIXTURES		Contents (litres) Valve outlet pressure (bar (g)) Valve outlet connection																1460 200 Side outlet Handwheel 5/8" BSP (f)						6780 200 Side outlet Handwheel 5/8" BSP (f)
CARBON DIOXIDE/AIR MEDICAL GAS MIXTURE (5% CO ₂ /95% AIR)		Contents (litres) Valve outlet pressure (bar (g)) Valve outlet connection																1350 200 Side outlet Handwheel 5/8" BSP (f)						6780 200 Side outlet Handwheel 5/8" BSP (f)
HELIUM/OXYGEN/NITROGEN MEDICAL GAS MIXTURE (56% N ₂ /35% O ₂ /19% He)		Contents (litres) Valve outlet pressure (bar (g)) Valve outlet connection																1310 200 Side outlet Handwheel 5/8" BSP (f)						6580 200 Side outlet Handwheel 5/8" BSP (f)

PIN INDEX VALVES



VALVE TYPES



Water Capacity(litres)	1.2	1.2	2.0	2.0	2.0	2.0	2.0	2.0	2.32	4.68	9.43	9.43	9.43	9.43	9.43	10.0	10.0	10.0	23.6	40.0	47.2	50.0	
Approx dimensions including valve	mm	290 x 100	430 x 89	480 x 100	520 x 100	520 x 100	455 x 100	480 x 100	485 x 100	535 x 102	865 x 102	670 x 175	690 x 175	930 x 140	930 x 140	930 x 140	680 x 180	940 x 140	940 x 143	1320 x 178	1540 x 230	1520 x 229	1540 x 230
Approx dimensions including valve	in	11.4 x 3.9	16.9 x 3.5	18.9 x 3.9	20.5 x 3.9	20.5 x 3.9	17.9 x 3.9	18.9 x 3.9	19.1 x 3.9	21.1 x 4	34.1 x 4	26.4 x 6.9	27.2 x 5.5	36.6 x 5.5	36.6 x 5.5	36.6 x 5.5	26.8 x 7.1	37 x 5.5	37.0 x 5.6	52 x 7	60.6 x 9.1	59.8 x 9	60.6 x 9.1
Approx weight (empty)	kg	2.3	2.0	3.7	2.7	2.7	4.8	4.1	3.1	3.4	5.4	9.9	10.0	14.5	14.5	14.5	15.5	15.5	10.0	34.5	51.0	68.9	51.0
Approx weight (empty)	lb	5.1	4.4	8.2	6.0	6.0	10.6	9.0	6.6	7.5	11.9	21.8	22.0	32.0	32.0	32.0	34.2	34.2	22.0	76.1	112.4	151.9	112.4
6ft (1.83m)																							
																							
	AZ	C	AD	CD	DD	PD	RD	ZD	D	E	AF	DF	F	LF	VF	AV	HX	ZX	G	AK	J	L	

The cylinder data card indicates the water capacity, dimensions, empty weight, gas capacity and valve type. The indicated cylinder colours are those specified in BS EN 1089-3 and ISO 32. Other countries do not necessarily use the same colours and care should be taken to identify correctly gas cylinders brought into the UK from overseas. All BOC cylinders are fitted with a colour coded and date marked test ring under the cylinder valve. This allows BOC to identify cylinders requiring internal inspection or hydraulic testing before refilling.

- Suitable for use in MRI environment.
- Most common cylinders used within the hospital.
- Specialist use cylinders used within the hospital.
- Other medical cylinders used within the hospital.

(1) Domiciliary use only.

NOTES: * The indicated cylinder is for specialised applications and availability is restricted.
** Vapour pressure of liquefied gas at 15 degrees Celsius.
*** Integral valve features a live content gauge, on/off handwheel, built-in flowmeter and regulator. Schraeder outlets are product specific to accept probes to BS 5682.
**** Always identify the cylinder content by the information on the label.

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- 8.37 Such a method of storage is not to be encouraged, as the cylinders are vulnerable to mechanical damage and tampering. Efforts should be made to provide appropriate safe storage.

Manifold rooms

- 8.38 Manifold rooms should not generally be used as general cylinder storage areas (but see paragraph 8.47).
- 8.39 Only cylinders of the gases required for connection to the manifold should be kept in the manifold room. The manifold room should not be used for any other purpose (but see paragraphs 8.42–8.47).

Note

All manifolds may be sited together in the same manifold room, and it is therefore essential that cylinders of different gases stored within this room are kept segregated to ensure the efficient changeover of manifold cylinders.

- 8.40 The number of cylinders in manifold rooms should be restricted to the minimum required for operational and reserve purposes. This will include cylinders connected to the manifold(s) and a sufficient reserve to replenish one complete bank.
- 8.41 In the case of manifolds for nitrous oxide/oxygen mixtures, sufficient cylinders to replace two complete banks should be stored.

Exceptions

- 8.42 There will be small hospitals, dental units and other small sites where division of the storage area into “full” and “empty” bays, as described in this section, is not feasible.
- 8.43 Some sites, in the absence of a dedicated building, will also store small cylinders of all medical gas types in medical gas manifold rooms.
- 8.44 In such cases, the Authorised Person (MGPS) should complete a risk assessment to validate the storage of such cylinders in the manifold room.
- 8.45 Care should be taken to ensure that different gas types and full and empty cylinders are segregated as clearly as possible and provided with a labelling system that clearly indicates the cylinder status (see [paragraph 8.157](#)).
- 8.46 The Authorised Person (MGPS) should ensure that appropriate training is being carried out on an ongoing basis.

- 8.47 The manifold room may be used for essential storage of nitrous oxide/oxygen mixture cylinders (on trolleys) to permit temperature equilibration before use with directly connected equipment.

Cylinder store construction

Location

- 8.48 Cylinder stores should be located at ground level – not underground, for example in a basement.
- 8.49 Cylinder stores should be located as close as possible to the delivery point. Wherever possible there should be only one delivery supply point for each site.
- 8.50 No parking should be permitted within the delivery and storage area other than for loading and unloading cylinders.
- 8.51 The location of the cylinder store should be marked clearly on the site plan for ease of identification in the event of an emergency.
- 8.52 Stores should not be located in close proximity to any installation that may present a fire risk or other hazard. BCGA's (2005) Guidance Note GN2 – ‘Guidance for the storage of transportable gas cylinders for industrial use’ gives separation distances for a range of gas types.

Construction materials

- 8.53 The floor should be essentially level and constructed of concrete or other non-combustible, non-porous material. A concrete finish is preferred and is likely to have a longer life. The floor should be laid to a fall to prevent the accumulation of water.
- 8.54 External and internal walls can be fabricated from wire mesh or brick. However, use of wire mesh for external walls will expose oxygen/nitrous oxide mixture to the risk of separation when the cylinders are subjected to low atmospheric temperatures.
- 8.55 “Blow-out” panels should be fitted into the external wall of any ground level store constructed as part of, and under, another building. These panels should be sited at a minimum height of 2.3 m above ground level.

Ventilation

- 8.56 All cylinder stores should be covered and, when constructed of brick or other solid material, ventilated by means of high- and low-level vents.

A ventilation area of 1.5% of the total area of walls and floor will ensure adequate ventilation.

Signage and labelling (including Hazchem signs)

8.57 The following signs should be posted:

- a. safety signage (Hazchem notices) in accordance with the requirements of the Health & Safety (Safety Signs & Signals) Regulations 1996, BS 5499-5:2002 and the Health and Safety at Work etc Act 1974 should be posted in and outside any area where cylinders are stored;
- b. a store identification notice. Suitable wording could be: “Medical gas storage area – smoking, welding and naked lights prohibited”;
- c. a store contents notice, clearly indicating the contents of the store;
- d. a medical gas cylinder identification chart and other relevant safety warning charts, posted inside the store;
- e. an “emergency actions” notice, giving details of emergency action procedures and location of keys and contact numbers, should be clearly posted on the front of the cylinder store.

Access

- 8.58 Clear and secure access to all cylinder stores is required, including adequate space for vehicular access and cylinder loading/unloading.
- 8.59 Access to the store should be key-controlled. A duplicate key should be kept in a locked box with a transparent front cover at the main fire entrance, gatehouse or equivalent building so that, in the event of a fire, a member of the fire brigade may obtain a key immediately he/she enters the hospital site. The transparent front of the box should be labelled: “Break cover to obtain key for emergency use only”.
- 8.60 Where this would not be desirable for security reasons, a prominent notice clearly stating the location of the key should be displayed.
- 8.61 The store should have easy access for trolleys. The cylinder bays should be arranged to allow trolleys to be safely manoeuvred and cylinders to be loaded and unloaded.
- 8.62 The doors should be large enough to facilitate cylinder loading/unloading and should be on an external wall. The emergency exit should be provided with a panic-release lock. Doors should open outwards.

Emergency access/exit

- 8.63 If the travel distance from the access doors to any part of the stores exceeds 15 m, additional emergency exits should be provided. The advice of the local fire safety officer should be sought.

Fire protection

- 8.64 All cylinder stores should be free from naked flames and all sources of ignition, and should be designated “no smoking” areas.
- 8.65 Appropriate fire-fighting equipment should be provided either within the store or at a convenient (signed) location nearby. The fire brigade should be notified of the location of the stores and any emergency access keys.
- 8.66 General fire precautions applicable to medical gas pipeline systems are given in the “Fire precautions” section of Chapter 9.
- 8.67 Smoke/heat detectors should be installed in ready-to-use medical gas cylinder stores in hospitals with an automatic fire detection system in accordance with ‘Firecode’.

Electrical installations/lighting

- 8.68 Electrical installations in gas storage areas are addressed by BS EN 60079-10:2003 and BS EN 60079-14:2003.

Notes

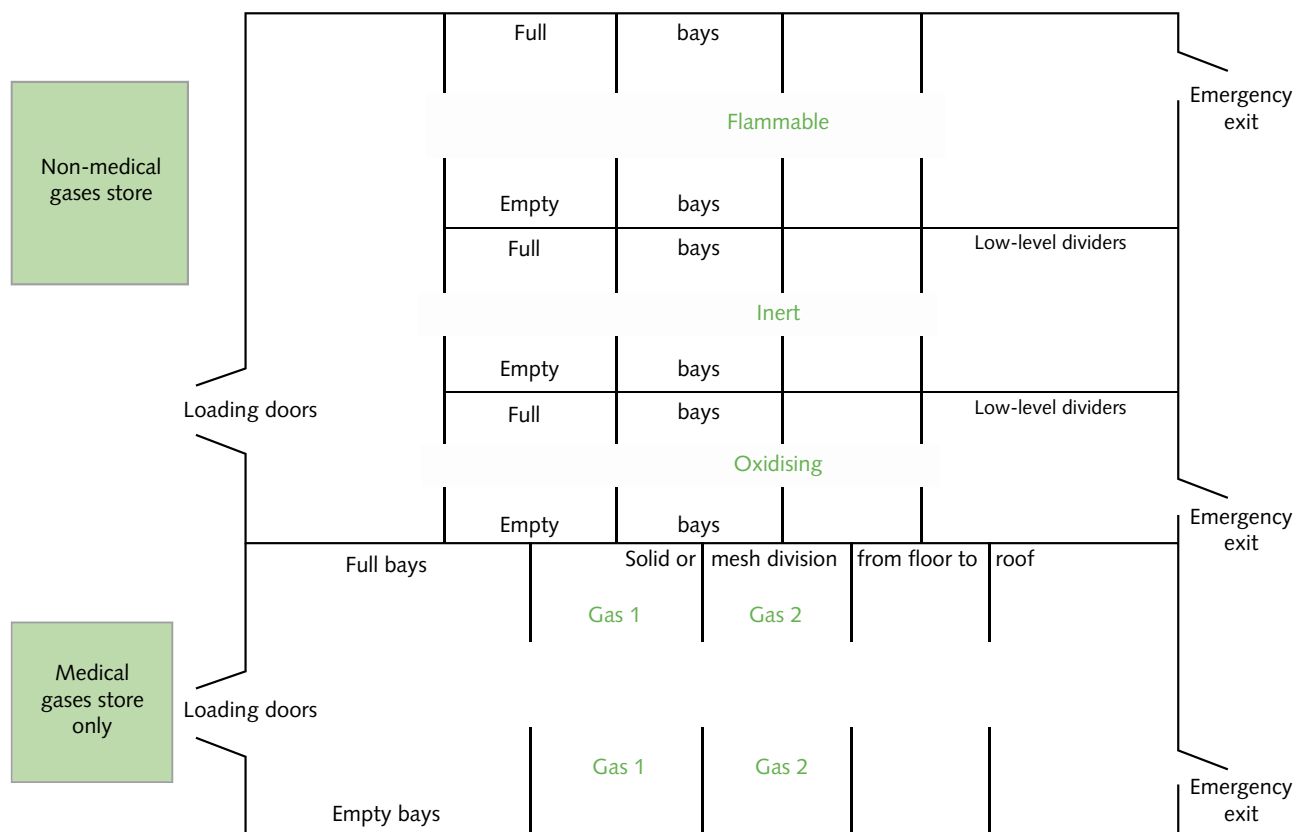
BS EN 60079-10:2003 is intended to be applied where there may be a risk of ignition due to the presence of flammable gas or vapour, mixed with air under normal atmospheric conditions.

It covers the classification of hazardous areas where flammable gas or vapour risk may arise. The standard also gives details about the protective measures that need to be applied to reduce the risk of explosions.

The standard sets out the essential criteria against which the risk of ignition can be assessed. It also gives guidance on the design and control parameters that can be used to reduce such a risk. Area classification is also a method of analysing and classifying the environment where explosive gas atmospheres may occur. This will facilitate the proper selection and installation of the apparatus to be used safely in that environment, taking into account gas groups and temperature classes.

- 8.69 On a hospital site, BS EN 60079-10:2003 supports the Dangerous Substances and Explosive Atmospheres Regulations 2002.
- 8.70 In medical gas stores containing oxygen, nitrous oxide, nitrous oxide/oxygen mixtures, medical air, medical carbon dioxide, helium/oxygen mixtures and oxygen/carbon dioxide mixtures, electrical installations will not require gas-tight fittings. However, to ensure mechanical and environmental protection, electrical installations should be completed in “pyro” or SWA (steel wired armoured) cables, with suitably glanded fittings.
- 8.71 Some medical gas mixtures (for example lung function mixtures) may contain flammable agents (denoted by a red band on the cylinder shoulder). If these mixtures are stored with non-flammable medical gases in a well-ventilated store, the wiring techniques in paragraph 8.70 will still apply.
- 8.72 For all other flammable gases/gas mixtures (for example pathology/industrial gases and stores combining a medical/industrial or medical/pathology function), the degree of protection of the electrical system against gas ingress will require specialist assessment against the standards in paragraph 8.69.
- ### Segregation of gases/cylinders
- 8.73 Cylinder stores for medical gases should only contain medical gas cylinders.
- 8.74 Industrial and pathology gases cylinders should be stored in a separate, appropriately designated store.
- 8.75 Separate, clearly identified bays should be provided for full and empty cylinders.
- 8.76 Separate areas for different gases should be provided, but it is not necessary to construct a physical barrier unless it is convenient to do so (see Figure 4).
- ### Cylinder restraint
- 8.77 Adequate means of securing large cylinders should be provided to prevent falling.
- 8.78 Smaller cylinders should be stored horizontally on metal racks, suitably protected to prevent damage to cylinder paintwork.

Figure 4 Cylinder storage for medical and non-medical gas cylinders



- 8.79 Trolleys carrying cylinders may be stored in the area for immediate use, but care should be taken to ensure that cylinders are suitably restrained to the trolleys.

Personal protective equipment

- 8.80 Personal protective equipment/clothing should be provided and used. Any loss or damage should be reported immediately.

Store temperature

- 8.81 Stores are intended to be well-ventilated, and therefore may not offer the degree of protection needed to prevent the separation at low temperatures of an oxygen/nitrous oxide mixture into its components. It is important that cylinders of this gas mixture are kept above 10°C for 24 hours before use, and arrangements should be in place to ensure that cylinders of this gas mixture collected from a cold store are not used immediately for patient treatment.
- 8.82 A hazardous situation could arise if cylinders are subjected to extremes of temperature. Cylinders should be kept away from sources of heat, including steam pipes and hot, sunny positions.

Cleanliness

- 8.83 The store must be kept clean, dry and free from flammable material. Rubbish, chemicals etc must not be stored with the cylinders. The area should be swept regularly and, where necessary, weeds removed from the immediate vicinity. Flammable weedkillers must not be used.

Signage

- 8.84 Appropriate safety signage should be provided in all cylinder stores in accordance with Chapter 14, Part A.

Handling of cylinders

General

- 8.85 Cylinders can be heavy (for example, an empty J-size steel cylinder weighs approximately 70 kg) and bulky, and should therefore be handled with care only by personnel who have been trained in cylinder handling and who understand the potential hazards.

- 8.86 Cylinders should not be dropped, knocked, used as “rollers”, or be permitted to strike each other violently.

- 8.87 Cylinders and valves should be kept free from oil, grease and other debris.

Note

Oil and grease in the presence of high pressure oxygen and nitrous oxide are liable to combustion and should not be used as a lubricant on any gas cylinder or equipment. In particular, the cylinder valve, couplings, regulators, tools, hands and clothing should be kept free from these substances.

- 8.88 Cylinders should not be marked with chalk, crayon, paint or other materials, or by the application of adhesive tapes etc. A tie-on label indicating the content state may be attached to the cylinder.
- 8.89 Smoking and naked lights should be prohibited in the vicinity of all cylinders.
- 8.90 Cylinders should always be secured during transportation and in use.
- 8.91 Safety devices, including pressure-relief devices, valves and connectors should not be altered or by-passed.
- 8.92 Repairs, alterations or modifications should not be undertaken.
- 8.93 Markings used for identification of cylinder contents, pressure-testing of cylinders, tare weights etc should not be defaced or removed. This also applies specifically to cylinder product labels.
- 8.94 Cylinders should not be painted or otherwise obscured in a manner that would prevent identification of their contents, and care should be taken to preserve their labels and surface finish.
- 8.95 Cylinders used for industrial purposes should not be used for medical applications. Similarly, medical gases should not be used for non-medical applications.
- 8.96 Cylinder valves should not be dismantled or tampered with.
- 8.97 Leaking cylinders should be removed from service and returned to the gas supplier (see [paragraphs 8.133–8.146](#)).
- 8.98 Cylinder valves should always be closed after use and when cylinders are empty. Keys/spanners for

Protective clothing

- 8.99 Heavy protective gloves (preferably textile or leather) and protective safety footwear should be worn when loading or unloading cylinders to minimise the risk of injury. Gloves, protective boots and overalls should be clean and free from oil, grease and hand creams etc.
- 8.100 Additional precautions are required for handling cryogenic gases (see paragraphs 8.162–8.170).

Note

When handling smaller cylinders, the use of protective gloves may be inconvenient. Extra care should be taken to avoid injury and to make sure that hands are free from oil or grease before the cylinders are handled.

Trolleys, trucks and vehicles

- 8.101 A suitable trolley, conforming to BS 2718:1979, should be used for transporting cylinders whenever they are moved.
- 8.102 Where different types of conveyance are used to transport several cylinders together, they should be clean, the cylinder supporting surfaces should be free from grease, oil and hand creams etc, and they should be reserved for the transportation of gas cylinders.
- 8.103 Precautions should be taken to prevent cylinders falling from trolleys, trucks or vehicles.
- 8.104 Vehicles transporting gas cylinders and using public roads should, where applicable, be appropriately marked in accordance with the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2004.

Unloading equipment

- 8.105 The hoist or tail-loader used with the delivery vehicle should be as clean as is practicable, and mechanical parts shielded to prevent contamination of cylinders with oil, grease and hand creams etc. Care should be taken to avoid transfer of oil, grease and hand creams etc from the winch to cylinders.
- 8.106 Cylinders should not be lifted by their guards or valves unless specifically designed for that purpose.

Note

In some circumstances it may be necessary to lift cylinders with the aid of an electric winch. This may necessitate attaching a wire rope around the cylinder valve. Staff carrying out this operation must be properly trained, and the hoist should be subject to regular insurance inspection where applicable.

Transportation of cylinders with attached equipment

- 8.107 In some circumstances it may be necessary to transport cylinders with equipment attached. Unless it is essential for a patient to continue receiving a supply of gas, the cylinder valve should be closed and any gas contained in the equipment or regulator should be safely vented to atmosphere before transporting the cylinder.
- 8.108 Lung ventilators, oxygen therapy apparatus and other equipment for use with cylinders should be so designed as to render the entire assembly stable during storage, transportation and use. If castors are used, they should conform to BS 2099:1989.
- 8.109 Mobile equipment should be suitably buffered to reduce damage to the fabric of the healthcare buildings.
- 8.110 When serving a patient, equipment and cylinders must be secured during transportation to prevent injury and interruption of supply. For moving J-size cylinders, the use of trolleys with a third (or more) rear-mounted wheel(s) is strongly recommended.

Note

Specially designed cylinder carriers are available for both wheelchair and patient transport trolleys and these must be used.

Preparation of cylinders for use

- 8.111 To ensure patient and staff safety, Medical Device Alert (MDA) Safety Notice SN2000(07) 'Medical gas cylinders: risk of fire' advises that:
- porters and users ensure a high standard of cleanliness when storing, transporting or connecting medical gas cylinders to regulators or other medical devices, particularly with respect to the presence of oil, grease and hand creams etc (for example barrier creams);

- b. users open medical gas cylinders slowly;

Note

When equipment is coupled to a cylinder, the cylinder valve should initially be opened as slowly as possible, as rapid opening can cause a sudden adiabatic increase in downstream gas pressure. The consequent temperature rise may result in ignition of combustible material in contact with the hot gas downstream. Only regulators designed for oxygen use should be used for this service, as they are constructed to prevent this occurrence.

- c. if resistance to opening of the cylinder is excessive, the cylinder should not be used and should be returned to the manufacturer/supplier with a label to indicate the problem (pharmacy must be informed);
- d. users read, understand and follow all instructions and labelling provided by the manufacturer/supplier.

Note

Serious incidents have occurred as a result of ignition occurring within the cylinder valve or regulator. This has been attributed to friction generated by particulate matter, such as dust or dirt, within the system when the cylinder valve is opened.

- 8.112 Cylinders and their associated equipment should be protected from contact with oil, grease and hand creams etc, bituminous products, acids and other corrosive substances.
- 8.113 Equipment should be subject to planned preventative maintenance (see [Chapter 10](#)).
- 8.114 Defective equipment should be notified to the appropriate body in accordance with the defect reporting system (see [Chapter 3](#)).
- 8.115 Cylinder preparation checklist:
 - a. check the cylinder label to ensure the correct gas has been supplied;
 - b. the tamper-evident seal should be removed, and any plastic outlet cap removed and left attached to the valve for refitting after use;
 - c. cylinders should only be used in conjunction with equipment designed for their use;
 - d. cylinder identification labels should not be removed or obscured. No permanent marking

or painting should be made to the cylinder shell except by the manufacturer/supplier;

- e. lubricants, sealing or jointing compounds should not be used when connecting cylinders to pressure-reducing regulators. The cylinder valve, regulator and associated equipment should always be clean and free from oil, grease and hand creams etc and other debris;
- f. cylinder and equipment connection interfaces and their washers or O-ring seals should be inspected to make sure that they are in good condition. Damaged sealing washers and O-rings should be replaced. Not more than one sealing washer should be used at each interface;
- g. portable nitrous oxide/oxygen cylinders should ideally be stored at above 10°C before use; if cylinders are stored at temperatures lower than 0°C for long periods before use, they should be warmed above 10°C for three hours and then inverted at least three times to ensure the correct gas specification. Under no circumstances should cylinders be immersed in water before use;
- h. in the case of large (G-size) nitrous oxide/oxygen mixture cylinders, they should be stored upright within the manifold room at a minimum temperature of 10°C for a period of 24 hours before connection to the manifold.

Note

Large cylinders of nitrous oxide/oxygen mixture brought to the manifold room from a cold cylinder store will not normally be used immediately, as enough cylinders for two complete manifold changes should be stored in the manifold room.

As most cylinder replacements take place at intervals longer than 24 hours, it will not be necessary to store manifold cylinders horizontally before use, provided that the manifold room is kept above 10°C.

Operating cylinder valves

- 8.116 Undue force should not be used to open or close cylinder valves, or to attach connectors to cylinders.
- 8.117 All cylinder valves should be opened gently. Tapping the operating key gently with a soft-faced (copper) mallet is acceptable, but undue force should not be used. If it is obvious that injury or

damage could arise from trying to open a sticking valve, the cylinder should be removed from service and returned to the supplier as a faulty cylinder.

- 8.118 Opening cylinder valves slowly will prevent a sudden rise in pressure in the system. It is at this time when there will be most stress on components and when most explosions will occur due to adiabatic compression of any oil, grease or hand creams etc that may be present.
- 8.119 The cylinder valve should be fully opened (slowly, anticlockwise) using the appropriate cylinder key, or hand-wheel where fitted, and then turned clockwise a quarter turn.
- 8.120 If there is any leakage of gas, the cylinder should be removed from service and returned as faulty.
- 8.121 Do not attempt to tighten gland nuts etc, as this may cause damage to the valve.
- 8.122 To close the valve, turn the spindle or hand-wheel clockwise. Hand pressure only should be used to close the valve.

Connection and disconnection of cylinders

- 8.123 Porters with specific medical gas training are known as Designated Porters (MGPS).

Safety note

Only persons who have had specific training in the safety of medical gases, manual handling techniques and cylinder changing procedures should be allowed to change cylinders on medical gas manifolds or medical equipment.

- 8.124 The following procedure may be posted on the manifold room wall adjacent to the manifold:

Manifold cylinder-changing procedure (for Designated Porters (MGPS))

- Ensure that hands are clean and grease-free before handling any medical gas cylinders or equipment and, where cylinders are handled on a regular basis, that safety footwear is being worn.
- Use heavy protective gloves (preferably textile or leather) and eye/face protection.

Important – when a bank of cylinders requires changing, all cylinders in that bank must be changed.

- Inspect the Bodok seal in the cylinder yoke for wear or damage. Change if necessary, taking care not to expose the surfaces to grease, oil or hand creams etc; use only one Bodok seal on each cylinder yoke.
- Check the name of the gas on the collar of each cylinder, the expiry date and the cylinder colour code. If in doubt, refer to the cylinder data sheet displayed in the manifold room.
- Remove the plastic seal, but always retain the valve cover caps fitted to bull-nose cylinder valves for refitting after use.
- Remove empty cylinders from the medical gas manifold one at a time, and replace each empty cylinder with a full cylinder immediately.
- Connect the cylinder to the manifold and tighten firmly by hand or with an appropriate spanner. Do not put undue strain on the manifold tail-pipe and do not use any lubricant or sealing compounds.
- Using the correct cylinder key (or hand-wheel/knurled knob where fitted), slowly open the cylinder valve anticlockwise to its fullest extent and then turn it back by a quarter turn.
- Check that there are no leaks between the cylinder valve and the manifold. This can usually be determined by listening. If in doubt, leak-detection fluid can be used, but always wipe off excess fluid with a clean damp cloth.

Note

Only leak-detection fluid suitable for use with all types of medical gas should be used.

- Once the bank has been fully changed, check that the contents gauge is reading 137/200 bar (137/200 kPa x 100) or full; and check the number of cylinders changed and readings on line pressure and contents gauges.
- Remember to sign the register.
- If a problem or fault is detected or suspected, inform the estates department immediately.
- Ensure that any faulty cylinders (for example leaking or damaged) are not left in the manifold room. They must be labelled “faulty” and kept separate from all other cylinders. Pharmacy must be notified.

8.125 Additional guidance can be added to the above list. For example:

- a. Outside normal working hours, it is the responsibility of the head porter to ensure that all appropriate portering staff comply with the above manifold cylinder-changing procedure.
- b. The pressure of cylinders connected to emergency reserve manifolds (ERMs) must be recorded in the “cylinder change register” at each cylinder change. If this pressure has fallen to 100 bar (30 bar for nitrous oxide), Estates should be notified of a possible leak. If there is an obvious leakage of gas (for example a hissing sound) from ERMs, the Estates department should be informed immediately.
- c. The handles attached to the nitrous oxide tail-pipes are not spanners. They are used to restrain the tail-pipe while the appropriate spanner is used to tighten the connecting nut. Using the handle as a spanner will cause serious damage to the tail-pipe and may result in personal injury.
- d. To ensure ERM cylinders are not used beyond their refill date: every ten manifold cylinder changes, remove ERM cylinders and connect them to the main manifold as part of the cylinder-change routine. Fit the ERM with fresh cylinders.

Procedure for changing cylinders on medical equipment

8.126 In this operation, the equipment is connected to the cylinder via a pressure regulator, a high pressure flexible hose and a cylinder yoke or, in the case of star valves (or other integral flow-controller type valves), a flexible low pressure tube.

Note

Always make sure that you are connecting equipment designed for the gas. Oxygen and medical air flowmeters read differently if interchanged.

8.127 The threads connecting different gas flowmeters to a regulator may be the same (for example oxygen and medical air).

Note

Nitrous oxide/oxygen mixture flowmeters have a different thread from others.

8.128 Do not use a normal ward flowmeter (0–15 L/min) when a paediatric type should be used (0–1.5 L/min).

8.129 Where a pressure-relief valve is fitted to protect downstream systems, it should be indelibly marked with its relief pressure value. Regulators should be indelibly marked with the maximum outlet pressure range. Pressure gauges should be in accordance with BS EN 837-1:1998.

8.130 Needle valves or similar devices should not be used in place of pressure-reducing regulators, as excessive pressure may develop downstream of such devices and result in possible injury to personnel and damage to equipment.

8.131 The connection procedure is as follows:

- a. Prepare the cylinder for use as above.
- b. Check the sealing washer at the valve/connector interface.
- c. Connect the cylinder to the equipment and tighten firmly with the correct spanner or by hand (as appropriate). Do not use excessive force.
- d. Before opening the cylinder, check that the equipment and other flow control valves are turned off.
- e. For two-stage regulators, turn the outlet pressure control to “off”, usually fully anticlockwise.
- f. Using the correct key (or knurled valve knob), open the cylinder valve slowly, fully anticlockwise and then back a quarter turn.
- g. Check for leaks, either by using leak-detection fluid, or by closing the cylinder valve and observing to see whether the high pressure gauge on the regulator starts to fall. If a leak occurs:
 - (i) between the cylinder valve and equipment:
 - carefully tighten the connecting nut. Close the cylinder valve, vent any gas trapped within the equipment and open the cylinder valve slowly. If the leak persists, turn off the cylinder valve, vent any gas safely to atmosphere and detach the cylinder from the equipment;
 - where the connection incorporates a seal (either O-ring or Bodok seal), this should be replaced and the cylinder reconnected

to the equipment, following the procedure outlined above.

(If a leak still persists, the equipment may need to be replaced. The manufacturer and/or electro-biomedical equipment (EBME) department should be informed, as appropriate, in accordance with the operational policy.)

- (ii) via any part of the valve or between the valve and the cylinder:
 - where the leak appears to be caused by the cylinder valve, notify the supplier of the faulty cylinder and retain for return under the “faulty cylinder” procedure (see paragraphs 8.132–8.141).
- h. Slowly adjust the pressure regulator/flow controller to the correct setting.
- j. Open equipment flow control valve(s) slowly, checking for correct equipment operation.

Safety notes

- A naked flame or lighted cigarette should not be used to detect leaks.
- Only proprietary leak-detection fluids should be used and then wiped off with a clean damp cloth after use to avoid possible contamination of the fittings.
- Defective pressure-reducing regulators, gauges and equipment may be hazardous in use. A system should be set out in the operational policy to ensure that defective items are withdrawn from use and repaired or replaced as necessary.
- No attempt should be made to repair, alter or modify any cylinder or its valve.
- Sealing or joining compound should not be used to rectify leaks.
- Cylinders with damaged or very stiff valves should be labelled appropriately and returned to the supplier.

8.132 The disconnection procedure is as follows:

- a. Turn off the cylinder valve and vent excess gas from the equipment regulator and connecting hoses by opening the equipment flow control valves for a few seconds. On a manifold, gas from the tail-pipe will vent as the cylinder connection is loosened.

- b. Shut off any equipment control valves.
- c. Using the correct spanner (or by hand), disconnect the cylinder from the equipment or tail-pipe.
- d. Do not vent the cylinder or leave the cylinder valve open.
- e. Replace plastic valve covers on F- and G-size cylinders.
- f. The cylinder should be returned to the empty rack in the cylinder store as soon as possible, checking that any contents status label has been amended as appropriate.

Defective cylinder classification

8.133 Gas suppliers usually classify defective cylinders under two categories: “faulty” and “incident”.

Faulty cylinders

8.134 These are described as those where the complaint is minor and the patient is not put at risk. Examples are:

Contents	Empty or partially empty where the cylinder is not required for immediate use.
Cylinders	Faulty valve operation. Damaged valve outlet. Minor leaks from valve.

Incident cylinders

8.135 These are described as those where the complaint is serious and the patient is considered to have been at risk. Examples are:

Contents	Wrong gas in cylinder or wrong gas specification. Gas contamination in cylinder. Abnormal patient reaction to gas. Cylinder empty when required for immediate use. Doubts about gas identity. Incorrect labelling.
Cylinders	Shell failure/damage. Ignition of shell or valve. Discharge from safety valve or bursting disc. Serious cylinder valve leak
Note: Cylinders involved in a fire or having ignited are also classified as incident cylinders.	

Dealing with defective cylinders

8.136 The MGPS operational policy should contain an appropriate procedure. The general procedure outlined in paragraphs 8.137–8.146 can be used as the basis for the policy entry.

General procedure

8.137 Telephone the gas supplier and be prepared to give:

- customer name and address;
- the person you wish to receive the investigation report, if required;
- the number of cylinders involved;
- the batch number, filling date, expiry date, cylinder size code and gas for each affected cylinder;
- a description of the fault.

8.138 The cylinder should be stored away from all other cylinders and have a defective cylinder label attached (these can be made/purchased locally).

8.139 A replacement should be provided when the defective cylinder is collected.

8.140 Local reporting procedures (for example to pharmacy) should be followed, particularly in the case of incident cylinders, as the Department of Health may have to be notified.

8.141 **The cylinder(s) should not be allowed back into general circulation.**

8.142 When the replacement cylinder is delivered, the driver will leave a delivery note and will be carrying a faulty (yellow) or incident (red) cylinder label.

8.143 Check that the label details are correct and sign as requested.

8.144 Ensure that the driver attaches the label to the correct cylinder using the bag provided.

8.145 If the defective cylinder is not available for return, give reasons on the reverse side of the label and return it to the driver.

8.146 A copy of the investigation report, along with a covering letter, will be sent to a nominated person (usually the QC Pharmacist).

Stock control and receipt of cylinders into stock

8.147 The objective of stock control and accounting is to ensure that the correct cylinders are received and used, and that unnecessarily large stock holdings are avoided. It is also important to avoid excessive stock holdings of empty cylinders for which rental charges continue to apply. This may be achieved by using the gas supplier's proprietary stock management system that utilises the bar-code information on cylinders to assist in efficient stock management control.

Ordering from suppliers

8.148 The written procedure detailing the method of ordering cylinders from commercial suppliers should be available in the appropriate departments.

8.149 An order should clearly specify that the gas is for medical purposes. It should also specify the gas required and the cylinder size, and indicate that the cylinders and valves should comply with BS 341-3:2002, BS EN ISO 407:2004 and the relevant parts of BS 5045.

8.150 Ordering and stock-control records should be maintained to suit local requirements. These records should include the name of the gas, date of receipt, expiry date, cylinder size, batch number of each cylinder and quantity of cylinders received.

8.151 Automatic replenishment systems may be used in conjunction with the gas supplier, provided that an agreed procedure is specified.

Returns to suppliers

8.152 Empty cylinders should not be retained longer than necessary in the main store, but returned at the earliest opportunity to the supplier to avoid unnecessary rental charges. This may also be covered by the automatic replenishment system described above.

Issue from stores

8.153 The following should be implemented:

- a. a written procedure should detail the system by which cylinders are requisitioned for use;
- b. a record of issues should be kept. The record should include the name of gas, size of cylinder, date of issue, expiry date, number of cylinders issued and the department, ward or name of

recipient. This may be covered by the proprietary stock management system.

Return of cylinders to stores

- 8.154 A written procedure should also be used for the return of empty or unused cylinders to the main store and for return to the supplier.
- 8.155 Cylinders placed in, or returned to, the ready-to-use store should be checked for leakage to ensure that the cylinder valve is turned off.
- 8.156 An adequate number of keys should be available.

Receipt of cylinders into stock

- 8.157 Cylinders that do not conform to the following requirements will not be accepted:
- Each cylinder should have:
 - a product identity label;
 - a batch label.
 - Cylinders should be clean and free from rust and scale, and the paintwork should be in a condition enabling easy identification from the colour-code chart (BS EN ISO 407:2004).
 - There should be a tamper-evident seal over the valve outlet.

Procedures for the rotation of stock

- 8.158 A written procedure should be prepared, giving details of a rotational stock-control system.
- 8.159 The main store should be large enough to permit the use of a rotational stock-control system. Racks for small cylinders should be designed to assist rotation of stock.
- 8.160 Where a system incorporating an in-use bay and a latest-delivery bay is used, the in-use bay should be emptied before a fresh delivery is loaded into it. Appropriate movable signs should be available.

Cylinder contents – status labels

- 8.161 Labels indicating the status of a cylinder's contents as it progresses from cylinder store to manifold (or equipment) and back to the store are particularly useful when cylinder storage space is limited and full and empty cylinders are easily mixed. A typical label is shown in Figure 5.

Figure 5 Example of cylinder contents status label

Hospital

Contact

EMPTY

Date

IN USE

Date

FULL

Date

Note

With the cylinder full and in store, the whole label is attached to the neck. On removal from store, the “full” section is cut or torn off and the cylinder is put into service. When it is empty (or used to its maximum useful capacity), the “in use” section is removed and the cylinder is returned to the store to await collection. Each section is dated accordingly.

Handling of cryogenic liquid equipment

General

- 8.162 For full safety instructions on liquefied atmospheric gases, the advice of the gas supplier should be sought.

Storage

- 8.163 Dedicated, well-ventilated and signed areas should be allocated to the storage of cryogenic liquids.
- 8.164 Dewars and larger vessels should not be stored in medical gas cylinder stores.

Note

Reference should be made to the British Compressed Gases Association's (BCGA) (2000) Code of Practice 30 (CP30) – 'The safe use of liquid nitrogen dewars up to 50 litres'.

Protective clothing

- 8.165 Protective clothing is only intended to protect the wearer from accidental contact with liquefied atmospheric gases or parts in contact with it.
- 8.166 Non-absorbent leather gloves should always be worn when handling anything that is, or has recently been, in contact with liquefied atmospheric gases. The gloves should be loose-fitting so that they can be removed easily. Sleeves should cover the ends of gloves. Gauntlet gloves are not recommended because liquid can drip into them. Woven materials are best avoided, but if they are used for protective clothing, it is essential to ensure they do not become saturated with cold liquid.
- 8.167 Goggles or a face mask should be used to protect the eyes and face where spraying or splashing of liquid may occur.
- 8.168 Overalls, or similar type clothing, should be worn outside leather shoes. These should preferably be made without open pockets or turn-ups where liquid could collect.

8.169 Trousers should be worn outside shoes for the same reason.

8.170 If clothing becomes contaminated with liquefied atmospheric gases or vapour, the wearer should ventilate them for a minimum of five minutes by walking around in a well-ventilated area, avoiding exposure to naked flames.

Safety notes – use of liquid nitrogen

In addition to its low temperature hazard, liquid nitrogen will cause depletion of oxygen as it vaporises in a storage area. This hazard is exacerbated by spillage of the nitrogen with ensuing rapid vaporisation.

Serious incidents involving liquid nitrogen spillage have occurred, and the BCGA's Code of Practice (CP 30) detailing safety requirements and procedures in the storage, use and handling of liquid nitrogen dewars up to 50 L in capacity should be consulted before this gas is used.

This document also gives advice on the safe transport of dewars in hospital lifts.

See also the Department of Health's Estates and Facilities alert DH (2005) 13 – 'Liquid nitrogen'.

9 General safety

General

- 9.1 The safety of MGPS is dependent on four basic principles:
- identity;
 - adequacy;
 - continuity;
 - quality of supply.
- 9.2 Identity is assured by the use of non-detachable gas-specific connections throughout the pipeline system, including terminal units, connectors etc, and by the adherence to strict testing and commissioning procedures of the system.
- 9.3 Adequacy of supply depends on an accurate assessment of demands and the selection of plant with capacity appropriate to the clinical/medical demands on the system.
- 9.4 Continuity of supply is achieved by the specification of systems that have primary, secondary and tertiary (third) means of supply. (In the case of vacuum, the emergency reserve provision necessitates the use of portable suction devices.) Alarm systems are provided to ensure that staff are aware of the status of the medical gas systems; additionally, medical gas systems are connected to the emergency power supply system.
- 9.5 Quality of supply is achieved by:
- the use of gases purchased to the appropriate Ph. Eur. requirements or produced by plant performing to specified standards;
 - the maintenance of cleanliness throughout the installation of the system; and
 - the implementation of various testing and commissioning procedures.

Modifications

- 9.6 Special precautions are required when existing installations are to be modified or extended, in order to ensure that the supply to patients is not

compromised or that any section of the pipeline system remaining in use is not contaminated. The section to be modified should be physically isolated from the section in use. Closure of isolating valves is insufficient for this purpose. Where AVSUs and LVAs have been installed, the blanking spades (as appropriate) should be used. This isolation procedure is not required when work is to be carried out on individual terminal units, providing that no brazing is required.

- 9.7 Modification of existing systems may be detrimental to the overall performance of the system. In the case of older systems, there may be insufficient capacity to permit the flows encountered today. Before contemplating the extension of an existing system, an assessment should be made of the existing system to ascertain whether it has sufficient capacity to support the proposed additional flows that will result from the changes.
- 9.8 Any work involving alteration, modification, extension or maintenance work on an existing system should be subject to the permit-to-work procedure – see [Chapter 6](#).

Safety statement for users of oxygen equipment

- 9.9 In the liquid state, oxygen is pale blue with a boiling point of -183°C at atmospheric pressure. In the gaseous state, oxygen is colourless, odourless, tasteless, non-toxic, non-irritant and non-flammable. It will, however, strongly support combustion, and is highly dangerous when in contact with oils, greases, tar-like substances and many plastics.
- 9.10 When oxygen therapy equipment is in use, fire and safety warning signs/labels should be conspicuously displayed at the site of administration to alert the patient, healthcare staff and visitors that oxygen is being used and that appropriate precautions need to be taken.

- 9.11 When oxygen is being administered in paediatric departments, the text should include the precaution: “Only toys approved by the hospital fire officer may be given to the child.”
- 9.12 Oxygen canopies, hyperbaric chambers and tents should be labelled, advising that oxygen is in use and that safety precautions relating to its use should be observed. Labels should be attached to the fabric of the canopy/tent in a position easily seen by the patient, and also on the exterior in a position to be seen easily by healthcare staff and visitors.
- 9.13 Considerations may need to be given for signs in other languages.
- 9.14 All users of oxygen and associated equipment should know and understand the properties of oxygen and should be trained in the use of the equipment. This applies to all staff.
- 9.15 The health hazards associated with liquid oxygen are:
- Cold burns and frostbite.** Localised pain usually gives a warning of freezing, but sometimes no pain is felt or it is short-lived. Frozen tissues are painless and appear waxy, with a pale yellowish colour. When the frozen tissue thaws, it can result in intense pain, with associated shock. Loosen any clothing that may restrict blood circulation and seek immediate hospital attention for all but the most superficial injuries. Do not apply direct heat to the affected parts, but if possible place the affected part in lukewarm water. Sterile, dry dressings should be used to protect damaged tissues from infection or further injury, but they should not be allowed to restrict the blood circulation. Alcohol and cigarettes should not be given.
 - The effect of cold on lungs.** Prolonged breathing of extremely cold atmospheres may damage the lung tissue.
 - Hypothermia.** A risk of hypothermia arises when liquefied atmospheric gases are released. All persons at risk should be warmly clad. Hypothermia is possible in any environment below -10°C , but susceptibility depends on length of exposure, atmospheric temperature and the individual; older people are more likely to be affected.
 - The formation of mist.** When liquefied gases are released and evaporation takes place, a white mist is formed by the condensation of moisture in the atmosphere. The mist formation may

introduce potential hazards because of poor visibility. In the event of mist formation, extreme caution should be exercised when evacuating the area.

Material compatibility

- 9.16 Gaseous oxygen vigorously supports combustion of many materials that do not normally burn in air, and is highly dangerous when in contact with oils, greases, tarry substances and many plastics. Only materials approved for oxygen service may be used.

Protective clothing for handling cryogenic gases

- 9.17 See [paragraphs 8.165–8.170](#). For more detailed safety instructions on liquefied atmospheric gases, the advice of the supplier should be sought.

Other medical gases

- 9.18 Guidance available from the manufacturers should be followed.

Fire precautions

- 9.19 The general guidance on fire precautions given in ‘Firecode’ should be followed. Specific guidance on fire precautions relating to cylinders is given in [Chapter 8](#).
- 9.20 Guidance is also available from the gas supplier; any specific recommendations should be followed.
- 9.21 Fire can occur when the following three conditions are present:
- flammable materials;
 - oxidising atmosphere;
 - ignition.
- 9.22 Flammable materials should not be present in cylinder stores, manifold rooms or liquid oxygen compounds. It may not, however, be possible to avoid the presence of flammable materials in the vicinity of the patient when medical gases are being used.
- 9.23 Flammable materials which may be found near patients include some nail-varnish removers, oil-based lubricants, skin lotions, cosmetic tissues, clothing, bed linen, rubber and plastic articles, alcohols, acetone, certain disinfectants and skin-preparation solutions.

- 9.24 An oxygen-enriched atmosphere may be present when medical oxygen or nitrous oxide/oxygen mixtures are used. Nitrous oxide also supports combustion.
- 9.25 Further guidance should be obtained from the fire prevention officer, the fire safety officer and the local fire brigade.
- 9.26 Ignition sources are numerous, and include:
- open flames, burning tobacco, sparks (which may also be produced by some children's toys); high-frequency, short-wave and laser equipment; hair dryers; arcing; and excessive temperatures in electrical equipment. The discharge of a cardiac defibrillator may also serve as a source of ignition;
 - electrical equipment not specifically designed for use in an oxygen-enriched atmosphere;
 - some non-electrical equipment. For example, a static discharge, which may be created by friction, may constitute an ignition source if easily ignited substances such as alcohols, acetone, some nail-varnish removers, oils, greases or lotions etc are present.
- 9.27 A mixture of breathing gases will support combustion. In an oxygen- or nitrous oxide-enriched atmosphere, materials not normally considered to be flammable may burn vigorously. Flammable materials ignite and burn more vigorously.
- 9.28 Clothing may become saturated with oxygen or nitrous oxide and become an increased fire risk. When returned to normal ambient air, clothing takes about five minutes for oxygen enrichment to reduce to normal conditions. Blankets and similar articles should be turned over several times in normal ambient air following suspected oxygen enrichment.
- 9.29 Oil, grease and hand creams etc, even in minute quantities, are liable to ignite in the presence of high pressure oxygen or nitrous oxide. No oil, grease or hand creams etc should be used in any part of the MGPS. In particular, oil-based lubricants should not be used, and all fittings, pipes etc should be supplied degreased, sealed and labelled for MGPS. Details of these requirements are given in Part A.
- 9.30 The siting and general structural principles for the design of liquid oxygen storage accommodation are stated in Chapter 6 of Part A, and for plantrooms and gas manifold rooms in Chapter 14 of Part A. Cylinder storage should be as recommended in [Chapter 8](#).

Ventilation

- 9.31 Waste anaesthetic gas discharges are usually controlled by scavenging and/or ventilation to comply with the requirements of COSHH. Where oxygen is used for specific therapies, for example in oxygen tents or in CPAP ventilation regimes, oxygen enrichment may occur. It is essential, therefore, that adequate general ventilation be provided to avoid the hazard.

Note

A risk assessment should be carried out to assist the need for local oxygen enrichment monitoring.

10 Maintenance

General

- 10.1 An MGPS should be subjected to a planned preventive maintenance (PPM) schedule, which should be under the responsibility of the Authorised Person (MGPS), irrespective of whether or not a full preventive maintenance scheme is being implemented in the hospital as a whole.
- 10.2 All work should be carried out in accordance with this Health Technical Memorandum and/or Model Engineering Specification C11, as applicable, and as modified from time to time.
- 10.3 All work on an MGPS, whether or not the supply is or is likely to be interrupted, should only be carried out under the instructions of, and with the prior permission of, the Authorised Person (MGPS).
- 10.4 All work carried out should be subject to the permit-to-work system and accepted by the Authorised Person (MGPS) before the contractor leaves the site.
- 10.5 A permit-to-work should be issued for all examinations, even where no interruption to the service is anticipated.
- 10.6 Inspection and maintenance should be carried out using one of the following methods:
 - a. on a contract basis by an approved specialist company (see paragraph 10.9);
 - b. by properly trained hospital staff (essential for daily, weekly and other tasks);
 - c. by a combination of (a) and (b) with a clear division of responsibility. For example: filter and oil changes performed by hospital staff; the remainder of the PPM work performed by contractors.
- 10.7 Since the Authorised Person (MGPS) is responsible for the operation of the MGPS, he/she will decide (in liaison with the QC Pharmacist) whether an MGPS should be taken out of, or brought into, service.

- 10.8 The MGPS operational policy should clearly set out the responsibilities and the procedures to be followed for all work on the pipeline.

Selection of contractors

- 10.9 It is a recommendation that all maintenance work on an MGPS should only be carried out by specialist contractors who are registered to BS EN ISO 9001/BS EN ISO 13485, with scope of registration defined to cover maintenance of MGPS and who can demonstrate compliance with the guidance given in this chapter.
- 10.10 Patient safety is paramount when carrying out any work on an MGPS and should be given priority over cost, although it is recognised that contracts are managed to be as cost-effective as possible.
- 10.11 The contractor should satisfy the trust that the maintenance tasks comply with the Pressure Systems Safety Regulations 2000.
- 10.12 Consideration should be given to the benefits that can be derived from longer contract terms between the client and the maintenance contractor.
- 10.13 The trust should have a medical gas operational policy that includes effective maintenance and sourcing of MGPS, which can be incorporated into a holistic approach. Some “added value” benefits that a trust can accrue from selecting the appropriate contractor can include the following:
 - full risk management and compliance analysis;
 - facility for full technical advice, support and back-up for service provision;
 - full asset management and expert life-cycle management;
 - condition-based monitoring and maintenance;
 - reliability-centred maintenance;
 - monitoring and setting of service quality targets;

- the proposal of any number of appropriate innovative solutions;
- a recognised quality assurance scheme.

Competency of contractors' staff

- 10.14** The trust should not be required to test the competency of contractors' staff, but it is the responsibility of the Authorised Person (MGPS) to satisfy himself/herself that the maintenance contractor is competent to carry out the work on the MGPS; this is implicit in the management of maintenance contracts for MGPS in order to ensure continuity of supply and patient safety.
- 10.15** The trust and/or the Authorised Person (MGPS) may, however, request documentary evidence of competency and training. This will include Competent Person (MGPS) training records, BS EN ISO 9001/BS EN ISO 13485 registration certificates, and calibration records of test equipment. Practical evidence may also be requested, such as a demonstration of brazing competency.
- 10.16** The contractor is responsible for ensuring that the staff working on any project are appropriately trained and qualified to carry out the work.
- 10.17** The contractor should not allow any staff to work unsupervised on a site unless they have received the appropriate training as detailed in this Health Technical Memorandum.
- 10.18** Ideally, the contractor should only employ his/her own staff to carry out the maintenance services.
- 10.19** Where the use of subcontractors is unavoidable, the contractor should obtain prior permission from the trust to use such staff.
- 10.20** The contractor should ensure that any subcontractors are at least as competent as his/her own staff and have received appropriate training and experience.
- 10.21** The contractor's project manager who has overall responsibility for the maintenance services should have received specific training on the maintenance requirements of an MGPS and the duties and responsibilities of an Authorised Person (MGPS), as defined in this Health Technical Memorandum.
- 10.22** The project manager should attend an accredited Authorised Person (MGPS) refresher course at least every three years.
- 10.23** The project manager should not only be familiar with the recommendations of this Health Technical Memorandum, but should also have knowledge and experience in the implementation of relevant codes of practice, such as the Pressure Systems Safety Regulations 2000.
- 10.24** The project manager is responsible for ensuring that only suitably trained and experienced service engineers (Competent Persons (MGPS)) who are familiar with this Health Technical Memorandum and the specialist techniques involved are employed on the maintenance contract.
- 10.25** The service engineers should have received at least the same training as required for a Competent Person (MGPS), as defined in this Health Technical Memorandum.
- 10.26** The contractor should maintain a training programme, and the training of each employee should be recorded in a training log.
- 10.27** The contractor should assign a skill level to each of his/her staff, and this should be used when selecting the appropriate staff for a particular task.
- 10.28** The trust may request copies of the training log entry of any of the contractor's staff.
- 10.29** Contractors' staff deemed by the Authorised Person (MGPS) to be incompetent for any reason should not be allowed to work on the pipeline.

General work procedures

- 10.30** The contractor should have made prior arrangements before each visit in order to minimise any disruption. All contractors' staff should report initially to the Authorised Person (MGPS) on arrival, and also before departure from the premises. Visits to the locations of supply plant and distribution equipment should not be made without the prior permission of the Authorised Person (MGPS).
- 10.31** The Authorised Person (MGPS) should ensure that the contractor's staff are familiar with the MGPS at the site before they carry out any PPM work.
- 10.32** No work should be carried out, including examination of terminal units, unless a permit-to-work has been issued by the Authorised Person (MGPS) in accordance with the permit-to-work procedure.

Note

It is expected that an Authorised Person (MGPS) will be available to sign permits for all work carried out on the pipeline.

However, in exceptional circumstances (for example emergency repairs to fractured pipelines), there may be occasions when the contractor arrives on site before the Authorised Person (MGPS).

The extent of the contractor's freedom to proceed without the issue of a permit in such circumstances must be documented in the MGPS operational policy.

- 10.33 While on the premises, the contractor should comply – and should ensure that his/her staff similarly comply – with the requirements of all relevant statutory safety legislation, such as the Health and Safety at Work etc Act 1974.
- 10.34 The contractor should at all times comply with the trust's safety policy, a copy of which should be signed by the contractor.
- 10.35 The contractor should provide his/her staff with appropriate identification acceptable to the trust and displayed at all times.

Note

The trust may also issue its own identity or other pass that the contractor should display if so requested. These must be returned to the Authorised Person (MGPS) on completion of the work.

- 10.36 The contractor should supply the Authorised Person (MGPS) with a method statement (or statements) applicable to the work. The Authorised Person (MGPS) will retain this.
- 10.37 The contractor should supply the Authorised Person (MGPS) with a copy of the contractor's health and safety policy. The Authorised Person (MGPS) will retain this.
- 10.38 The trust will provide details of its fire and health and safety policies, and the contractor will be required to comply with these. The contractor should instruct his staff in the requirements of the fire policy, although when working under a permit-to-work it will be the responsibility of the Authorised Person (MGPS) to ensure that the Competent Person(s) MGPS carrying out the work is/are fully conversant with the relevant fire and safety precautions. This is particularly

important in such instances as isolation of smoke detectors during hot work.

Monitoring of contractors' staff and services

- 10.39 To ensure that the maintenance service is being carried out in accordance with the contract, the trust should monitor the work and the performance of the contractor.
- 10.40 The Authorised Person (MGPS) should have responsibility for the satisfactory implementation of the maintenance service and for monitoring the maintenance work carried out by the contractor.

Note

The Authorised Person (MGPS) should ensure that the contractor's staff and performance are checked on a random basis. On a large site, it may be desirable to carry out a maintenance audit at least every six months.

- 10.41 The Authorised Person (MGPS) should arrange site meetings when necessary with the contractor's representatives to discuss progress. Meetings will normally be arranged if the trust is not satisfied with the level or standard of service, or if changes in contract details are required.
- 10.42 The contractor's project manager should be present at such meetings, together with the service engineers as appropriate.
- 10.43 The contractor's agreed attendance at progress meetings should form part of the contract.
- 10.44 A full record of the maintenance carried out is to be kept on site and updated following any work; the contractor should be given a copy of the maintenance record.
- 10.45 The Authorised Person (MGPS) should ensure that the service engineer has adequately reported any defects or remedial work required before leaving site.
- 10.46 The contractor should remove from the premises any of his staff if requested to do so by the Authorised Person (MGPS), or where the trust so requests on the grounds of efficiency, competence or public interest.

Test equipment

- 10.47 The contractor should provide all appropriate test equipment, having identified the test equipment appropriate to each task in the method statement.
- 10.48 It is not the responsibility of the Authorised Person (MGPS) to provide test equipment for the contractor. The consequences of loaning test instruments to a contractor must be clearly understood, particularly in terms of insurance liability and equipment calibration.
- 10.49 The test equipment should be constructed and used in accordance with the requirements detailed in Chapter 15, Part A.
- 10.50 The test equipment should be calibrated in accordance with the manufacturers' recommendations, but in any case against recognised national standards at a frequency of no less than annually.

Note

Calibration records should be kept by the contractor and produced for inspection by the Authorised Person (MGPS), if requested.

- 10.51 When carrying out tests on terminal units, it is not sufficient to use only blank test probes. Such blank test probes should only be used for leak tests; a calibrated flowmeter and pressure gauge, together with appropriate calibrated jet, should be used to carry out flow and pressure-drop tests.

Provision of services

- 10.52 The contractor should submit with the tender a general statement on his/her capability to support the requirements of the trust. This should include details of the various resources available to him/her; number of staff employed, levels of competence and emergency support provision; and should define the level of technical advice and support that the contractor can provide. The contractor should also identify other similar contracts being undertaken. A sample maintenance contract is given in [Appendix C](#).
- 10.53 The contractor should carry out the services specified in the contract on the dates or at the intervals specified in the contract.
- 10.54 A schedule of minimum tasks to be carried out is given in [paragraphs 10.84–10.161](#). This may be

modified by individual trusts, as appropriate, for their particular requirements.

- 10.55 Except where specifically provided for in the contract, and excluding emergency call-outs, all visits should be scheduled to take place on weekdays, between 08:30 and 17:00 hours.
- 10.56 In addition to the regular maintenance, the contractor should provide service engineers to carry out additional tasks as requested by the Authorised Person (MGPS). These tasks may be routine replacement of wearing parts, non-urgent maintenance tasks or emergency call-out tasks.
- 10.57 For non-urgent tasks, the extent, cost and time, and approximate duration of the work should be agreed between the contractor and the Authorised Person (MGPS) and confirmed in writing.
- 10.58 Before leaving site on completion of the tasks, the contractor should report to the Authorised Person (MGPS) to sign off the permit-to-work and to provide any other information regarding additional work required, remedial work, faults found etc.
- 10.59 The Authorised Person (MGPS) should sign to the effect that the work has been carried out satisfactorily before the contractor leaves site.
- 10.60 It is the Authorised Person (MGPS)'s responsibility to satisfy himself/herself that the work has been carried out in accordance with the contract.

Emergency call-out procedures

- 10.61 In addition to the planned maintenance tasks as specified in the contract, the contractor should provide an efficient call-out service in the event of any breakdown or other incident occurring between planned maintenance visits.
- 10.62 This service should be available 24 hours per day, 365/6 days per year.
- 10.63 The exact procedure for initiating a call-out will vary with each trust. Each trust should, however, prepare appropriate procedures, which should be set out in the MGPS operational policy and which should be agreed with the contractor and included in the contract documentation.
- 10.64 Typically, the trust should identify the person(s) responsible for contacting the contractor (that is, the Authorised Person (MGPS)), shift engineer, duty engineer etc), the procedure for generating and authorising an official order for the work, and

the procedures for obtaining access to the site at all times.

- 10.65** The contractor should, normally within a maximum of one hour of receiving an emergency call, contact the person nominated in paragraph 10.64. He/she should ascertain the nature and extent of the problem and provide an estimate of the arrival time of a service engineer on site.
- 10.66** For emergencies where the supply has been, or will likely be, interrupted or where patient safety will be affected, the contractor should attend site within a maximum time from receipt of the initial call as specified in the maintenance contract by the trust. The geographical location of the trust, number of the trust's Authorised and Competent Persons (MGPS), and availability of technical guidance are all considerations when defining the emergency response time. For normal circumstances, a response time of two hours is recommended.
- 10.67** The contractor should be responsible for maintaining a reasonable stock of spares to facilitate emergency call-outs. The contractor should be familiar with each site and should therefore be able to reasonably anticipate the most likely spares commonly required.

Method statements

- 10.68** A list of recommended tasks to be carried out at specified frequencies is given in paragraphs 10.84–10.161.
- 10.69** The tasks are listed as generic tasks. The contractor should prepare a method statement for each of the tasks identified.
- 10.70** The method statement(s) will be applicable to the actual plant and equipment installed on a particular site.
- 10.71** The method statement should include the following information:
 - sequence of tasks to be performed;
 - procedures to be followed, for example permit-to-work, obtaining permission from ward staff, safety procedures etc;
 - the grade, competency and number of staff to carry out the tasks;
 - the test equipment to be used;
 - the approximate time to complete the tasks;

- the documentation/report to be completed.

Access to systems

- 10.72** It should be the responsibility of the trust to ensure that access to the plant and systems are available to the contractor.
- 10.73** The contractor should liaise with the Authorised Person (MGPS) to arrange for such access at least one week before the due date of the visit.
- 10.74** It may not be practical for access to operating departments and other high-dependency areas to be available during normal working hours; in this case the contractor should liaise with the Authorised Person (MGPS) to ensure that the work is carried out with due regard for the clinical requirements. Where access to such departments is routinely unavailable during normal working hours, this should be specified in the contract.
- 10.75** No member of a contractor's staff should gain access to any part of the MGPS without prior permission of the Authorised Person (MGPS) and issue of an appropriate permit-to-work.

Records

- 10.76** A signed and dated report form should be completed after every visit to the premises and after any work is carried out. It should include the following details:
 - company;
 - time and date of arrival on site;
 - trust order number;
 - location, number and type of plant/equipment;
 - details of work carried out, that is, planned maintenance, breakdown,
 - emergency call-out etc – details of breakdown as reported, cause of breakdown, action taken;
 - details of spares used;
 - details of any further work required, urgency and implications;
 - details of defects noted and remedial work required;
 - time of leaving site;
 - name of contractor's staff and grades;
 - signature of:

- the contractor's engineers on site;
- the Authorised Person (MGPS) for the trust – on arrival and before departure;
- a representative (for example clinician/nursing officer) for the department visited (see paragraph 10.77).

10.77 For each area visited, the work record should be signed by the departmental representative (for example manager, nursing officer or clinician, as appropriate) with the time and date of the visit. This is to provide a written record that the particular department has been visited; it in no way implies any responsibility by the clinical or nursing staff with regard to the scope and effectiveness of the work carried out. Variations in signature protocols should be agreed with the Authorised Person (MGPS).

10.78 A maintenance log/plant history record is to be maintained for each plant item and is to be updated following each planned maintenance visit or any work carried out. The format of the maintenance log/plant history record is to be specified by the Authorised Person (MGPS), and the log/record should be kept by the Authorised Person (MGPS). A copy will be made available to the contractor for his records, if so requested.

10.79 Following the completion of the service, the contractor should affix a label to each plant item, which should provide the following information:

- contractor's name, address and telephone number;
- the date the work was carried out;
- name and signature of service engineer;
- date of next planned service.

10.80 In addition, a bar-code providing details of the service record may also be affixed.

10.81 It would not be practical to affix such a label to each terminal unit following planned maintenance. Therefore, a label giving the above information and the location of the terminal units should be affixed adjacent to the AVSU serving the area.

10.82 A schedule of the actual tests results for each terminal unit should be maintained and retained in the maintenance log.

Planned preventive maintenance (PPM) schedules

10.83 Appropriate PPM procedures are applied to MGPS to secure continuity of patient safety and are intended to be applicable to all MGPS, whether new or existing installations, irrespective of whether or not the systems comply with the recommendations in this Health Technical Memorandum.

10.84 Recommendations for the minimum tasks at the minimum recommended frequency, including particular details of daily and weekly tests, are given in [paragraphs 10.90–10.161](#). Daily and weekly tasks are usually carried out by the trust; however, the trust may wish the contractor to carry out these tasks as an additional contract.

10.85 In conjunction with the manufacturer's recommendations, the guidance given in these paragraphs should enable a PPM schedule to be prepared or enable management to scrutinise a contractor's proposals in order to ensure compliance with these recommendations.

10.86 The suppliers should be required to provide complete as-fitted drawings, circuit diagrams, valve charts and maintenance instructions, which should be used as the foundation for the PPM programme. For new plant, the PPM programme supplied by the manufacturers should be used.

10.87 The terms used in the PPM programme and their definitions are as follows:

- **Examine:** to make a careful and critical scrutiny of an item without dismantling, by using the senses of sight, hearing, smell and touch, to verify that the plant or equipment is in working order.
- **Test:** to operate the plant or equipment and/or use the appropriate testing instruments to ensure that plant or equipment is functioning correctly.
- **Check:** to make a thorough inspection for damage, wear or deterioration, and to ascertain that the plant or equipment is correctly adjusted to conform to the required standard.

10.88 The actual frequency of maintenance routines should be established from the manuals for the equipment and plant. Practical experience with equipment of different manufacturers, coupled with risk assessment and information from plant history logs, might well result in the need to vary

some frequencies and tasks in particular installations. An example of this would be the reduction in inspection frequency of terminal units from quarterly to six-monthly, or even annually, if records have indicated that no detriment to system operation will result from this decision.

- 10.89** For each of the tasks listed in paragraphs 10.90–10.161, where adjustments or other remedial actions are required, this should be carried out at the time. Where such action is not possible, for example where additional parts are required, this should be noted and reported to the Authorised Person (MGPS).

Specific maintenance tasks

- 10.90** Details are given below for daily, weekly, quarterly and annual maintenance tasks on a range of plant and systems.

Records

- 10.91** The results of each inspection, and any action taken to correct faults found during the inspection, should be recorded. Arrangements should be made so that action can be instituted to correct apparatus giving constant trouble caused by faulty design or by unsatisfactory conditions of any nature. Provision should be made for maintenance tasks and their frequency to be modified when necessary.
- 10.92** Counters that record the hours of operation of compressors and vacuum pumps are covered in Part A. The readings of these counters can be used in conjunction with the recommendations of the manufacturers for the modification of the programme.

Equipment checklists

- 10.93** The installations include a great number of AVSUs, pressure-regulating valves, filters, indicating lights and audible alarms. Equipment checklists should be prepared for each of these groups of items. AVSUs and pressure-regulating valves should be referred to by number in the checklist, and this number should correspond with that on the valve itself. It is usually convenient to arrange these checklists in such a manner that a record can be made against each valve showing whether it has been “examined”, “tested” or “checked” in accordance with the PPM programme.

Exclusions from these maintenance schedules

Cryogenic liquid oxygen system inspections/maintenance

- 10.94** The PPM programme does not cover the regular inspections considered essential for the safe operation of liquid oxygen installations. These duties will be carried out by representatives of the gas supplier (usually every six months) and should be accompanied by an appropriate MGPS permit-to-work.

Statutory inspections of pressure vessels

- 10.95** Statutory inspections of pressure vessels are also not covered in the PPM schedules, but should be included in the written scheme of examination for the MGPS.

Pressure safety valves

- 10.96** It is not recommended that safety valves are lifted; every safety valve should have a test certificate in accordance with this Health Technical Memorandum. The safety valve should be replaced every five years under a planned replacement procedure.

Note

Statutory obligations under the Pressure Systems Safety Regulations 2000 require the periodic testing of pressure safety devices. However, it is not appropriate to test an MGPS by either raising the line pressure regulator setting or manually unseating the relief valve. Such action could result in failure of anaesthetic equipment and, in the event of failure of the safety valve to reseal, considerable gas loss and further hazard.

Medical gas pipeline line distribution systems should be provided with a pressure-relief device downstream of the line pressure regulator connected by means of a three-way cock so that the safety device can be exchanged for a “certificated” replacement in accordance with the frequency required by the Regulations.

Full system overhauls

- 10.97** Full system overhauls may be recommended by equipment manufacturers but are not considered as part of the following PPM schedules. This work will necessitate shut-down of major plant items and provision of gas from reserve manifolds etc.

Note

It will be the responsibility of the Authorised Person (MGPS) to organise such work, in consultation with clinical, nursing and pharmaceutical colleagues.

Electrical tests

- 10.98** Electrical tests such as earth bonding resistance and insulation resistance should be checked in accordance with relevant Regulations. Results of these tests should be documented and kept with the appropriate plant history records.

Pipeline and cylinder-connected equipment

- 10.99** Equipment for use with medical gas cylinders and gas distribution systems should be subject to routine inspection and maintenance in accordance with the manufacturers' recommendations and, where appropriate, it should be subject to PPM (advice is given in the Medicines and Healthcare products Regulatory Agency's (MHRA) 'DB 2000(02) – Medical devices and equipment management: repair and maintenance provision'.
- 10.100** Only competent and qualified staff must carry out maintenance work.

Filters

- 10.101** Filters on MGPS should be changed at intervals recommended by the manufacturer, or if the filter becomes wet, or if the pressure drop across the filter exceeds the suppliers' specification.

Note 1

Plug-in type terminal unit filter assemblies used in association with breathing systems and air-powered tools do not form part of the MGPS.

Note 2

AGSS receiving system filters are prone to collecting lint, which blocks the filters and affects performance.

Note 3

The Authorised Person (MGPS) should liaise with the infection control officer to establish the need for a separate permit to be used in addition to the MGPS permit when changing bacteria filters on medical vacuum plant. A suitable permit is shown in [Appendix D](#).

- 10.102** A filter change procedure for vacuum system bacteria filters is given in [Appendix D](#).

- 10.103** These units should be serviced in accordance with the suppliers' specifications.

Blenders

- 10.104** Maintenance should be carried out in accordance with the manufacturers' instructions.

Compressed-air dryers and pressure swing adsorber (PSA) columns

- 10.105** Air-dryer desiccant or PSA-column molecular-sieve charges should be replaced with the appropriate material at intervals recommended by the supplier, or if the material has been proven ineffective.
- 10.106** A record of the type, batch number of desiccant and date of change should be kept.

Note

It is essential that the quality of gas from PSA and medical air compressors is tested at least quarterly, in accordance with the procedures in Chapter 15, Part A, of this Health Technical Memorandum.

Terminal units

- 10.107** Although terminal unit maintenance is listed as a quarterly task, the actual frequency of maintenance should be specified by the trust, taking into account the amount of daily use the terminal units undergo and also the age and design of the terminal units. As a minimum, the work should ideally be scheduled such that a quarter of the terminal units are serviced during each service visit.

Daily/weekly tasks

- 10.108** It is the responsibility of the Authorised Person (MGPS) to organise any necessary daily/weekly maintenance on the pipeline.

Note

It will be necessary to consult equipment suppliers and/or their equipment technical data to establish daily/weekly (or any other interim) maintenance tasks required to keep systems in good running order. In the absence of such information, the Authorised Person (MGPS) will be responsible for devising these tasks.

10.109 As a minimum, the following should be checked and any deficiencies or remedial action required should be notified to the Authorised Person (MGPS).

Daily – general tasks
Check all alarm panels, manifolds and plant visual indicators for correct function, absent displays or damage.
If any manifold is observed to be in operation on its “emergency reserve” bank, replacements for the empty cylinders should be made available immediately.
Check all plant and manifold pressure gauges for abnormal conditions.
Check all plant and manifolds for unusual noises, signs of overheating, vibration etc.
Check plant oil levels.
Weekly – general tasks
Safety notices – check that appropriate notices are clearly displayed in all plantrooms and cylinder stores.
“No smoking” notices – check that they are clearly displayed.
Discharge points/vents/vacuum/AGS – check that warning notices are clearly displayed.
Check that motor guards are in position and in good repair.
Notices warning of automatic start/stop – check that they are in position and legible.
Check that plantrooms are free from combustible material and with adequate access for maintenance.
Check that all cylinders are properly stored/secured and all batch labels are correct and in date.
Specific daily tasks for VIE plant
Check and record the vessel pressure and contents.
Check and record the pressure of the pipeline.
Check and record the pressures of the cylinders on the secondary manifold (should be above 68/100 bar – full cylinders will read 137/200 bar, depending on the type of manifold). If the pressure of either bank is below 68/100 bar and no “reserve low” alarm is indicated, inform the Authorised Person (MGPS).
Ensure that the compound is secured when leaving and that lights have been turned off.
Specific weekly tasks for VIE plant
a. Check mechanical joints for obvious signs of leaks.
b. Check for mechanical damage.
c. Check that the vessel(s) is (are) operating at normal working pressures, and record these.
d. Check that the plant output (pipeline) pressure is at normal, and record this.
e. Where a compressed gas cylinder manifold is used as a secondary supply, check that the cylinder pressures are above 50% of “full” pressure and record the actual pressures.
f. Record content level(s) of vessel(s).
g. Ensure that there is no build-up of rubbish/flammable material within the vessel compound.
h. Report all faults to the Authorised Person (MGPS)/gas supplier as necessary.
Where staff are available, (c) (d), (e) and (f) should be carried out on a daily basis.
Specific weekly tasks for compressed-air plant
Check compressor motor and plant control panels to ensure there are no alarm conditions.
Check and record hours run for each pump.
Visually check both compressors for security and any sign of oil leakage.
With compressor stationary, check that oil level is visible halfway up the sight glass. Inform Authorised Person (MGPS) if oil level is not correct or appears cloudy.
Manually open discharge valves on after-cooler and receiver drains and leave open for a few seconds, so that air-flow cleans the drains internally. Inform Authorised Person (MGPS) if more than 0.5 L of liquid is drawn off.
Operate compressor duty selector switch and ensure correct operation by monitoring while compressor is running on line.

Record running current of duty compressor.
Record compressor cut-in and cut-out levels on compressor control panel gauge.
Ensure both compressors are left in “auto” mode.
Check dryer control panel to ensure there are no alarm conditions.
Operate dryer selector switch and ensure correct operation by monitoring while compressor is running on line.
Inform the Authorised Person (MGPS) if any faults are recorded.
Specific weekly tasks for vacuum plant
Check pump motor and plant control panels to ensure there are no alarm conditions.
Check and record hours run for each pump.
Visually check all pumps for security and any signs of oil leakage.
Ensure vacuum pump oil level is visible between the top and bottom edges of the oil level sight glass. Inform the Authorised Person (MGPS) if the oil level is not correct, or oil appears cloudy.
Check bacteria filter and vacuum pump exhaust drainage flasks to ensure no liquid is present. Inform the Authorised Person (MGPS) if there is liquid present.
Record vacuum cut-in and cut-out levels on duty pump gauge.
Record running current of duty pump.
Ensure pumps are in “auto” mode.
Change over duty and stand-by pumps by use of “duty select” switch, if not automatic.
Inform the Authorised Person (MGPS) if any faults are recorded.

Routine testing and maintenance of VIEs/liquid cylinder systems

- 10.110** Agreement between the hospital and the medical gas supplier should ensure that the VIE/liquid cylinder system and associated equipment are maintained correctly.
- 10.111** Records should be kept of design, installation, maintenance and modifications that are carried out by the hospital and/or the gas supplier.
- 10.112** Although the gas supplier retains the responsibility for the maintenance of the VIE/liquid cylinder system, there should be an agreed routine checklist (see “**Specific weekly tasks for VIE plant**” under paragraph 10.109), to be carried out by the hospital, to ensure that the system is operating correctly.
- 10.113** These checks should form part of the agreement with the gas supplier, and should include the appropriate actions to be taken if the system is found to be operating outside its normal working parameters.
- 10.114** There is a tendency for the pipework and valves carrying the cryogenic liquid to “ice up”, and a system/procedure needs to be in place to ensure that any valves necessary to be operated to maintain safe working conditions are available for use at any time.

- 10.115** The alarm system should be tested regularly in accordance with the documented hospital procedures and based on the risk assessment.
- 10.116** To test the alarm system, each alarm condition should be initiated by the operation of a pressure switch. The control panel should be supplied with a built-in test facility that allows the pressure switches to be checked.
- 10.117** The high line pressure alarm requires specialist test equipment, and the gas supplier should normally be contacted to carry out this test.

Operational test of secondary supply system (for VIE, liquid cylinder and compressed gas cylinder manifolds)

- 10.118** At a frequency agreed with the gas supplier, the primary system should be shut down by isolation of the appropriate valves such that the operation of the secondary supply system, and associated alarms, can be checked. The procedure should be carried out by the gas supplier and should be supervised by the Authorised Person (MGPS).

Operational test of compressed gas cylinder emergency supply systems

- 10.119** At a frequency agreed with clinical and nursing colleagues, the Authorised Person (MGPS) will perform or supervise the closure of AVSU

pipeline isolation valves to areas supported by emergency supply system manifolds, and the correct operation of the manifold systems and any associated alarms will be confirmed.

- 10.120 Following all operational tests, the systems must be returned to normal operating mode, and levels of stock in primary, secondary and emergency supplies checked to ensure no major loss has occurred.
- 10.121 All alarm systems must be checked for correct indications following the tests.
- 10.122 All operational tests should be detailed in the MGPS operational policy.

Note

Examination of the contents (via pressure gauge readings) of an emergency supply system manifold should take place on at least a weekly basis.

Operational test of “emergency supply kits”

- 10.123 This should be carried out on a quarterly basis.
- 10.124 Each kit should be capable of providing the required gas flow without excessive pressure drop or leakage. (A minimum pressure of 3.8 bar should be maintained under full flow conditions.)
- 10.125 On an annual basis, the kits should be examined for damage to hoses and fittings, and components replaced as required.
- 10.126 Any further tests or component replacements that may be required under the Pressure Equipment Regulations 1999 should be determined and documented in the MGPS operational policy.

Quarterly tasks – introduction and safety

- 10.127 The procedures and checklists below may be used in conjunction with manufacturers’ data to prepare quarterly and annual maintenance schedules for MGPS plant and system components.
- 10.128 MGPS alarms will often be triggered by necessary work on the system; for example, it may be necessary to test pressure switches.
- 10.129 To minimise disruption to patient services, all clinical/nursing staff should be made aware of work on the pipeline and any alarms that may result. However, it is also essential that any alarms reported during the work are not dismissed as

spurious, as they may represent system fault conditions unrelated to the work in hand.

- 10.130 It is essential that all work is covered by an appropriate permit-to-work, as described in [Chapter 4](#).

Manifold systems – introduction and safety

- 10.131 Work on automatic manifolds will necessitate maintaining the hospital supply from the associated emergency reserve manifold system (ERM).
- 10.132 It is essential, therefore, that correct operation of the ERM is confirmed, as in [paragraph 10.142](#), before it is used as the sole means of supply.
- 10.133 The capacity of the emergency reserve manifold will be much less than that of the automatic manifold it supports. Therefore, adequate stocks of fresh replacement cylinders must be on hand during these procedures, in association with appropriate levels of labour needed to effect cylinder changes.
- 10.134 Examine the general condition of the manifold, tail-pipes and electrical connections before proceeding.

Manual ERMs – general

- 10.135 The structure of the ERM will vary according to the age and/or make of the unit.
- 10.136 If the ERM is not fitted with header-isolating valves (usually hand-wheel types), one cylinder valve will have to be kept closed during normal operation. On exhaustion of this cylinder (it is usual to change over at a cylinder pressure of about 20 bar), the other cylinder valve is opened and the “empty” cylinder valve is closed. The empty cylinder is then replaced.
- 10.137 On ERMs fitted with header-isolating valves, both cylinder valves are kept open during normal use, and changeover is effected by use of the high pressure valves (one being kept open and one closed).
- 10.138 Many manual ERMs are fitted with only one J-size cylinder per side, although up to five cylinders per side is possible.
- 10.139 The ERM should be fitted with pressure safety, main isolating and non-return valves (NRVs). The main ERM isolating valve should be kept “open” during normal use.

Automatic ERMs – general

- 10.140** A fully automatic manifold in support of a medical air compressor or VIE is generally identical in construction to those manifolds used in primary supply systems. The maintenance procedures detailed in **paragraph 10.143** will therefore apply.
- 10.141** The “reserve low” alarm indication, which is triggered from the pressure switches mounted on a manual ERM, will be initiated by changing over an automatic manifold ERM from “duty” to “stand-by” bank, rather than from cylinder content sensors.

Manual ERM maintenance tasks

10.142 Advise the hospital switchboard, or permanently staffed location, and relevant medical staff that the medical gas system is about to be tested and that alarms are likely.

1. Ensure that: - when the duty (primary) manifold is running, the reserve (secondary) manifold cylinders are full; - all system pressures are normal (that is, line pressure 4 bar, cylinder pressures either 137 bar or 200 bar, depending on cylinder supplier and manifold type); - all alarms are showing green “normal” lamps; - the automatic manifold main isolating valve is open; and - the manifold is supplying the hospital.
2. Close the isolating valve on the ERM slowly and confirm that there is no effect on the line pressure to the hospital.
3. Open all cylinder and header-isolating valves.
4. Check that the ERM safety valve is not passing, by cracking its downstream exhaust coupling and listening for a gas leak. Replace the valve with a sealed, certificated unit if necessary and repressurise the system.
5. Close one cylinder valve and detach the pin-index yoke slowly from this cylinder. Listen for a leak from the tail-pipe. A minor leak is permissible and likely but an obvious major leak denotes failure of the tail-pipe non-return valve (NRV). If the latter happens, do not totally detach the tail-pipe but instead retighten it and test other tail-pipes in the same way. Any failed units can be replaced after all cylinder valves have been closed and the system has been depressurised. Repeat this test when the new tails have been fitted.
6. Close all cylinder valves.
7. Disconnect the outlet side of the regulator.
8. Open one cylinder valve and ensure full flow through the regulator.
9. Attach a test gauge to the regulator output.
10. Open one cylinder valve and check the static pressure of the regulator (should be approx. 3.9 bar). Observe this pressure for two minutes to ensure that there is no regulator creepage. Creepage will necessitate replacement and a repeat of this test.
11. Remove the test gauge and reconnect the regulator.
12. To test the “reserve low” pressure switch, open one cylinder/header-isolating valve until the cylinder content gauge indicates full pressure, and then close the valve.
13. If a bleed facility is present, open this carefully, or crack open the regulator outlet pipe.
14. Observe the falling pressure on the inlet pressure gauge.
15. When the pressure falls to 68/100 (or 137 bar on a 200 bar cylinder unit) (14 bar in the case of nitrous oxide) the pressure switch should close, initiating a “Reserve low” alarm on both the automatic panel and the primary alarm system. Adjust/replace switches as necessary.
NOTE For units fitted with two pressure switches, this procedure will need to be repeated to test the operation of each switch.
16. With the regulator outlet still cracked, momentarily open the ERM isolating valve and check that the ERM NRV is not passing. (Be prepared to shut this valve quickly if the NRV has failed.) Replace the NRV as necessary.
17. Finally, tighten all joints, open all cylinder valves and perform a final leak test on all joints.
18. With all cylinder/isolating valves in the normal operating positions, open the primary ERM isolating valve and check that there is no effect on line pressure.
The ERM is now ready for use.

Automatic manifold maintenance tasks

10.143 Before proceeding with these tests, correct operation of the ERM should be confirmed as described above. Replacement, full, in-date cylinders should be immediately available.

10.144 Relevant staff should be advised of possible alarm indications.

10.145 All manifolds should be able to supply gas with or without an electrical supply. Individual manifolds, however, may differ in the way in which this is achieved and the alarm conditions that will show in the event of a power failure. Local variations should be noted for future reference, as it is not normal to test the manifold under power failure conditions.

1. Confirm that the ERM has full cylinders attached, that its cylinder/header-isolating valves are in the correct position, and the ERM isolating valve is open .
2. Close the primary (automatic) manifold isolating valve slowly and ensure that the ERM output pressure (line pressure) is maintained before proceeding with the primary manifold tests.
3. Close all cylinder valves on both banks and observe the control panel cylinder pressure gauges. There should be no pressure drop. A pressure drop at this stage will necessitate investigation, including a check of the safety valve(s) as in item (4) of the “Manual ERM maintenance tasks” at paragraph 10.142 .
4. Reduce downstream pressure and then close up the leak. (A leak can be created via the test point or commissioning valve. For manifolds without a commissioning valve or test point, it will be necessary to crack open a union on the outlet regulator/pipeline.)
5. On the left-hand bank, momentarily open the nearest cylinder valve to the control panel (just sufficient to repressurise the panel and force the manifold into “left bank running” mode) and then re-create a small leak downstream of the final regulator(s). Open one cylinder on the right bank momentarily to clear the right bank “empty” lamp, and then close its valve.
6. Let the pressure drop until changeover occurs, and record: a. changeover pressure (that is, to right bank) – compare this with the manufacturer’s data; b. correct operation of manifold panel and alarm system indicators, that is, on the manifold panel: • left bank “running” lamp will extinguish; • left bank “empty” lamp will illuminate; • right bank “running” lamp will illuminate; • control panel alarm status indicators and main alarm panel indicators will show “change cylinders”, accompanied by an audible alarm on the main alarm panel.
7. Mute the alarm at the panel.
8. Let the pressure continue to fall, noting the pressure at which the manifold indicator shows “low” (yellow) on the right bank and at which both the alarm status and main alarm panel indicators show “change cylinders immediately”. This will also be accompanied by an audible alarm. Mute this alarm at the panel.
9. If the pressure is falling only slowly, there will be time to test the NRVs in the tail-pipes on the left bank by disconnecting them and listening for leaks.
10. Reconnect the cylinders and, on the right bank, open the cylinder control valve nearest to the control panel.
11. The manifold control panel alarm conditions should now change to the following: Right bank “running” Illuminated Right bank “empty” Extinguished Right bank “low” Extinguished Left bank “running” Extinguished Left bank “empty” Illuminated Left bank “low” Extinguished The alarm status indicator and the main alarm panel should display “change cylinders” but the “change cylinders immediately” lamp should extinguish.
12. On the left bank, momentarily open the cylinder valve nearest to the control panel and observe the alarm conditions. On the control panel only the right bank “running” lamp should now be illuminated. On the alarm status indicator and the main alarm panel, a green “normal” lamp should be showing.
13. Repeat (4) to (11) for the right bank, noting all pressures and alarm conditions and testing the right bank tail-pipes for leaks.

14. Keep the leak open and note the pressure at which the control panel “low line pressure” indicator illuminates. At this point, the alarm status and alarm panel indicators should display a “pressure fault” indication (with an audible alarm) in addition to “change cylinders” and “change cylinders immediately”.
15. Close the leak and slowly open up one cylinder valve. Note the pressure at which the “low pressure” lamp clears.
16. Open all cylinder valves and check that all indications return to a “normal” status.
17. Finally, open the primary manifold isolating valve slowly and confirm that the manifold begins to supply gas and the ERM shuts down.
Note 1 Annual testing of the regulator(s) output pressure and the line pressure switch settings are recommended. This should be carried out while the manifold is isolated and the system is being supplied by the ERM. The set pressures of the low or high pressure switch settings should not be tested by raising or lowering the manifold line pressure while the manifold is on-line to the system. A calibrated test gauge can be either attached to the regulator output if convenient, or plugged into the terminal unit of the test point. Note 2 Some panels are fitted with heaters, usually on the high pressure feeds to the regulators. These thermostatically-controlled units help prevent condensation and/or freezing of regulators/pipework under high gas-flow conditions. Nitrous oxide manifolds are particularly prone to this problem and are often fitted with these heaters. It is usually possible to establish that the heaters are working by momentarily touching the heater body during operation. Beware! The surface of the heater may be hot enough to burn. However, it may be switched off, or the system may be above the cut-in temperature of the thermostat. If heater failure is suspected, confirm by appropriate electrical tests.

Compressed-air plant maintenance tasks

- 10.146** A full test of the medical compressed-air units will require isolation of plant before work. It is therefore absolutely essential that the emergency reserve manifold be tested for correct operation before proceeding with these tasks.
- 10.147** Great care must be taken to ensure adequate stocks of fresh cylinders are available for the ERM, and procedures should be carried out as carefully and safely as possible on the plant.
- 10.148** A fully automatic manifold, which will come on line automatically in the event of plant failure, is specified in this Health Technical Memorandum, but older systems may not be equipped with this feature. In many instances, only a small manual manifold (for example 1 x 2 J-size) is fitted. This may be able to supply the hospital for a few minutes only. All compressor support manifolds should be left with their isolating valves open.
- 10.149** Compressors will stop/start automatically. Additionally, it is not unknown for current to be switched to an isolated compressor of a duplex unit in the event of failure of the other compressor during servicing. To minimise the risks, always ensure that work takes place on an isolated unit switched to the “stand-by” condition. The “duty select” switch (or programmable unit) can be set to achieve this.
- 10.150** In all cases, relevant personnel should be advised of possible alarm indications.

1. Confirm that ERM isolating valve is open and the ERM is able to supply air to the pipeline system.
2. Before isolation of compressors takes place: (i) Check running of cooling fans where fitted. (ii) Record input and output temperatures of oil/after-cooler where fitted. (iii) Check safety valves/pressure gauges for condition and leaks (note gauge readings). (iv) Examine all drainage traps and their respective manual bypass valves (where fitted), and check for correct operation and opening; replace or repair if necessary. (v) Check the condition of all flexible components and associated electrical bonding. (vi) Check the receiver(s) for general external condition. (vii) Check the dryer columns for damage/rust. (viii) Check all visible electrical components for damage/overheating.
3. Isolate one of the compressors and check the following. (Note that a “plant fault” alarm will probably be given at this stage. The other compressor(s) should be selected as “duty” plant). (i) Holding down and fixing bolts – replace/adjust as necessary. (ii) Anti-vibration mountings bolts – replace/adjust as necessary. (iii) Air intakes, filters and silencers – replace/clean as necessary. (iv) Motor alignment – adjust as necessary. (v) Drive coupling or pulleys and belts – adjust/replace as necessary. (vi) Inter/after-cooler coils/fans – clean/replace as necessary. (vii) Oil levels and oil filter – top up/change as necessary. (viii) Motor windings and bearings – clean/replace as necessary.
4. Repeat (3) for the other compressor(s), making sure that you have changed over the “duty selector” switch and isolated the compressor you are to work on.
5. Switch on both/all compressors in “auto” mode. Plant operation can now be tested, either with or without the use of the ERM. If the ERM is to be used, it will be necessary to close the primary plant-isolating valve (slowly) to ensure that the ERM comes on line and is able to supply the hospital.
6. Open the receiver drain valve(s) slowly and record the cut-in pressure and unloaded and loaded running currents of the duty pump(s). (On a three-pump system, the second pump will cut in a few seconds after the first.)
7. Isolate the duty pump(s) and confirm that a “plant fault” alarm is initiated.
8. Continue draining the receiver(s) and record the cut-in pressure and loaded running currents of the stand-by pump(s).
NOTE If plant is fitted with a back-up pressure switch, the operation and set pressures of the switch can be checked now. Continue to drain receiver: check that the back-up pressure switch operates and record its pressure settings.
9. Close the receiver drain valve(s) and record the cut-out pressure of the stand-by pump(s).
10. Switch on the duty pump(s) isolator and put the stand-by pump(s) on manual control.
11. Record the cut-out pressure of the duty pump(s) and switch the stand-by pump(s) back to automatic control.

12. Change over the “duty selector” switch and repeat (5) to (11).
13. As a final test of operation, open the receiver drain valve(s) again and confirm that the duty pump cuts in.
14. Close the receiver drain valves and record the hours run for each pump.
15. The operation of the “low line pressure” switch can now be tested. The ease of this process will depend on its location in the system and the provision (or lack of) of a convenient leak/test point.
Note 1 It may be necessary to isolate the outlet line from the dryers/regulators in order to simulate pressure loss. If this is the case, affected valves must be reinstated to their original operating positions. Note 2 Dryer operation can now be tested. A large variety of dryers exists, including heated, heatless and compressor-cycled (usually in conjunction with the compressor unloading devices). Some dryer columns are fitted with pressure sensors, which will signal a plant fault alarm if the column has not repressurised after regeneration. It may not be possible to cycle the dryers quickly, although some dryer units offer a “high speed” mode, which will perform this function. Note 3 Some parts of the following procedure may not be relevant, therefore, to a particular model of plant; the manufacturer’s instructions must be followed. Note 4 Take care to isolate and bleed down all filters before dismantling.
16. Check filter element differential pressure gauges and/or age/running hours of filter, and replace as necessary.
17. Confirm that any filter auto-drains are operating correctly.
18. Record drying and reactivating pressures and confirm operation of cycling and repressurisation controls where possible.
NOTE Some systems have a “plant fault” alarm initiated by failure of a column to build up pressure after regeneration. This can be tested at this stage.
19. Test operation of the dryer change-over/control unit, both by manual selection (where appropriate) and by removing and shorting the dew-point sensor connecting cable. Confirm that a “plant emergency” alarm is initiated on this latter action.
NOTE Some units have multiple sensor connections. Those with sensors attached to dryer columns, in addition to a line dew-point sensor, may indicate a “plant fault” alarm when the former are shorted and a “plant emergency” when the latter is shorted.
20. Open the stand-by regulator’s input isolating valve slowly, while keeping its output valve closed. Listen for leaks.
21. Open up the stand-by regulator’s outlet valve and close the duty regulator’s inlet valve. Confirm that the hospital is being supplied with air and then open up the duty regulator’s inlet valve and isolate the stand-by regulator. Confirm that air is still being supplied.
22. Record the line pressure.
NOTE It is not a requirement of this Health Technical Memorandum to change over duty and stand-by regulators on a weekly basis.
23. If the plant isolating valve has remained open during these tests, it should now be closed slowly until the ERM is observed to come on line. Record the pressure at which this happens. If it is apparent that the ERM is not functioning, open up the plant isolating valve immediately, shut off the ERM and investigate the cause of the problem before proceeding.
Failure to comply with this instruction could lead to the death of a patient!
24. Finally, open up the plant isolating valve and confirm that all alarms are “normal”.
Note 1 – Pressure reducing stations Regulator sets attached to plant sourcing both 7 bar (surgical) and 4 bar (medical) air supplies will be provided with either regulating stations (receiver pressure to 7 bar; and 7 bar to 4 bar) in the plantroom or a regulating station (plant to 7 bar) in the plantroom and individual regulating stations (7 bar to 4 bar) situated local to areas where the 4 bar supply will be required. In all cases, these regulating stations will comprise duty and stand-by regulators and associated isolating valves (and possibly pressure-relief valves and filter assemblies). Individual regulators should be tested for operation as described in (21) above. Note 2 – Annual tasks (i) Check all electrical connections for security and damage. (ii) Check line pressure switch settings with calibrated gauge, where safe to do so. (iii) Check operation of dryer inlet solenoid and outlet NRV. (iv) Check calibration of dryer dew-point sensor.

Central vacuum plant maintenance tasks

10.151 To maintain a hospital supply during these procedures, it will be necessary to work on operating plant. Only one pump (or two on a three-pump unit etc) will be able to be isolated in any instance. Be aware that the other pump(s) will stop and start automatically.

10.152 Relevant staff must be warned of possible alarm indications and the need to provide stand-by supplies where loss of vacuum is considered critical.

10.153 If water or other liquids are detected in the bacteria filter drain flask(s), they should not be opened without first consulting the Authorised Person (MGPS) and the infection control officer.

1. Before isolation of pumps takes place:
(i) Check running of cooling fans where appropriate.
(ii) Examine exhaust drainage traps for oil carry-over. Clean out traps where necessary.
(iii) Check the condition of all flexibles and associated electrical bonding.
(iv) Check the receiver(s) for general external condition.
(v) Check all pressure gauges for correct operation.
(vi) Check all visible electrical components for damage/overheating.
2. Isolate one of the pumps and check the following (note that a “plant fault” alarm will probably be given at this stage; the other pump(s) should be selected as the “duty” plant):
(i) Holding down and fixing bolts – replace/adjust as necessary.
(ii) Anti-vibration mountings bolts – replace/adjust as necessary.
(iii) Exhausts (including labels), filters and silencers – replace/clean as necessary.
(iv) Motor alignment – adjust as necessary.
(v) Drive coupling or pulleys and belts – adjust/replace as necessary.
(vi) Cooling coils/fans – clean/replace as necessary.
(vii) Oil levels and oil filter – top up/change as necessary.
(viii) Motor windings and bearings – clean/replace as necessary.
3. Repeat (2) for the other pump(s), making sure that the “duty selector” switch has been changed over from the pump on which work is due to commence.
4. Switch on both/all pumps in “auto” mode. Plant operation can now be tested.
5. Open receiver drain valve(s) and record the cut-in pressure and unloaded and loaded running currents of the duty pump(s) as applicable.
6. Isolate the duty pump(s) and confirm that a “plant fault” alarm is indicated.
7. Record the cut-in pressure and the loaded running currents of the stand-by pump(s) where appropriate. (On a three-pump unit, the second pump will cut in a few seconds after the first.)
NOTE If plant fitted is with a back-up pressure switch, the operation and set pressures of the switch can be checked now. Continue to drain receiver, check that the back-up pressure switch operates, and record pressure settings.
8. Shut the receiver drain valve(s) and record the cut-out pressure of the stand-by pump(s).
9. Switch on the duty pump(s) isolator and put the stand-by pump(s) on manual control.
10. Record the cut-out pressure of the duty pump(s).
11. Switch the stand-by pump(s) to auto control.
12. Change the “duty selector” switch and repeat (6) to (12).
13. Open the receiver drain again and ensure that the duty pump(s) cut(s) in, then close the receiver drain(s).
14. Record the hours run for each pump.
15. Test the operation of the vacuum level “pressure fault” switch and respective alarm indicators by creating a small leak in the line to the switch. Record the pressure at which this alarm occurs and adjust the switch if necessary (should operate at 360 mm Hg).
Note 1 In practice it may be difficult to monitor this operating pressure due to the absence of convenient access points. In these cases, operation of the switch should be confirmed without measuring the pressure.
Note 2 As vacuum pumps are protected from possible contamination by bacteria filters, the vacuum pump oil and condensate are classified as hazardous not clinical waste, and can be disposed of in a similar manner to air compressor oil. To ensure that vacuum pump oil is not contaminated, it is important that the manufacturer’s recommendations for replacement of the bacteria filter(s) elements are followed. This is usually annually or after a specified number of hours, whichever comes soonest.

AGSS maintenance tasks

- 10.154** Bacteria filters are not always included in the air pathway of these units, and unnecessary exposure to the gas stream should be avoided.

Pump units

1. Ensure the pump securing bolts are tight – adjust if necessary.
2. Ensure that flexible pipework and any associated electrical bonding are in satisfactory condition. Replace as necessary.
3. Confirm operation of “mains on” and “running/normal” lamps.
4. Examine the exhaust terminals for occlusion and the exhaust drainage bottles for oil carry-over/condensation. Clean as necessary. Confirm terminal warning signage is in place.
5. Where a duplex system is fitted, isolate the duty pump and confirm that the stand-by pump cuts in. This action may be accompanied by a “pump failure” alarm, depending on the age and type of the system.
6. While the pump is isolated, examine oil level if appropriate (most units use sealed/self-lubricating bearings) and top up/replace as necessary.
7. Change over the “duty select” switch and repeat (5) and (6).
8. Locate the flow-regulating valve and clean out the mesh filter.
9. If the system is fitted with a low flow detector, momentarily disconnect the feed pipe to the sensor and confirm that a “system failure” alarm is given.
10. In the theatre area, check for correct operation of alarm indicators as the above tests proceed. It may be possible to test the system failure alarm by turning off the unit at the theatre control panel for about 30 seconds. Switching on should cause a system failure lamp to show. This should clear within a few seconds of switching on (depends on system).
11. Check motor windings and bearings – clean/replace as necessary.

Terminal units

- 10.155** In addition to the PPM tasks, a full recommissioning test, involving measurement and possible adjustment of the maximum negative pressure capacity of the pump, should take place on an annual basis, or if the terminal unit flow rates are grossly in error. A formal report on the recommissioning should be issued to satisfy the Health & Safety Executive requirements for a local exhaust ventilation system under the Control of Substances Hazardous to Health Regulations 2002 (COSHH). No part of an AGSS must be in use with patients and/or connected anaesthetic equipment when the testing takes place. The testing confirms that the performances of the system and terminal units are within specification.

- 10.156** Terminals should be dismantled and cleaned, and flows tested. Adjustment may be necessary. This test should be performed with all terminal units (other than the one under test) closed and then with other terminals open, as defined below.

Note

In any theatre suite comprising an operating theatre (with one or two terminal units) and an anaesthetic room (with one terminal unit), the anaesthetic room terminal should be open, but only one of the theatre terminals should be open during this part of the test.

Alarm panel maintenance tasks

1. Check each panel and any visible connecting cables for external damage/deterioration.
2. Push the “test” or (on some local area alarm panels) the “test/mute” button and ensure that all lamps are lit and an audible alarm is sounding.
3. Replace any lamps/LEDs as necessary and repeat the above test.
4. Disconnect the mains electricity supply by pulling the in-line fuse, and confirm that a system failure lamp is initiated together with an audible alarm.
5. With the electrical supply still disconnected, open the alarm panel (a special tool may be needed: care is required – there may be mains electrical contacts; pulling the fuse only isolates a single pole) and examine the interior for loose, damaged components and the external condition of the battery. Any corrosion should be removed and the source identified. Battery replacement may be required (observe polarity).
6. Close the panel and reinstate the mains supply. All alarms should return to the “normal” condition.
Note 1 In addition to the PPM tasks, testing of local alarm pressure switch settings should be undertaken annually/biannually. This can only be carried out without shut-down of the system if the pressure switch is connected to the pipeline via a minimum leak fitting. Note 2 It is important that pressure switches are tested remotely from the MGPS. Attempts to adjust system regulator settings as a means of testing the high/low pressure performance of these switches may have potentially fatal consequences for patients. Closing down AVSUs to simulate pressure loss is also not recommended.

The “engineer’s mute” facility

- 10.157** If an alarm condition is to be present for a long time (for example during work on a system which is depressurised), the audible alarm, which normally resets (after muting) every 15 minutes, can be disabled by opening the panel and pressing the “engineer’s mute” button.

Note

Other conditions present at the time will also be locked out. Close the panel and confirm, by pressing the “test” button, that the “engineer’s mute” has successfully locked out the condition. All other lamps should flash, the locked-out condition being steady. The lock-out should cancel as soon as the condition returns to normal.

MGPS pipework and pipeline components maintenance tasks

10.158 When inspecting pipeline components such as valves, particularly those that are left unlocked, great care must be taken to prevent inadvertent isolation of supplies.

General distribution system

Check for:
(i) Damage, especially serious abrasion, flattening of pipework and corrosion due to chemical or water leaks.
(ii) Absence of, or damage to, pipework protection methods, especially damage to ductwork and sleeving/mechanical shielding.
(iii) Security of/damage to electrical bonding.
(iv) Leaks – in any area, from fittings etc.
(v) Damage to, or removal of, fire stopping.
(vi) Absence of, or painting over of, exhaust/blow-down and pipeline identification labels, flow direction arrows, valve box labels etc.
(vii) Breaches of security to MGPS plantrooms, AVSUs, LVAs, valves, VIE compounds etc.
(viii) Accuracy of as-fitted drawings, identification markings, labelling etc.
NOTE Only sections of pipework visible during normal PPM will be inspected.

AVSUs/valves (and LVAs where accessible)

10.159 Valves in plantrooms are not normally locked, but the room door should be.

10.160 Valves in ducts should be kept locked in the normal operating condition. All AVSUs should be kept locked, and keys should be subject to a proper key control system.

Examine location cleanliness – clean as required.
Check correct labelling – rectify, as necessary, orientation of on/off valves for ease of operation.
NOTE Valve operation can be checked on shut down of all services to a ward/department.

Pressure reducing sets

Examine condition of all pressure regulators.
Check security of safety valves regulator mounting locking devices – where fitted.
Test creep regulators for correct settings.

Pendant units/booms

Examine security of fixings/mountings, freedom of movement (as applicable), labelling and colour-coding of hose assemblies.
Check leakage from hose assemblies.
NOTE It is not normally possible to ascertain the condition of hose assemblies by visible means. They should therefore be assigned a service life based on the complexity of the pendant fitting, the amount of movement it is capable of providing, and criticality of function of the pendant. Inspection of pendant fixings and mounts could be carried out at the same time as hose replacement.
Test pendant unit/boom rotation, retraction, braking etc.
NOTE Hose construction/repair is a specialist activity. If hose damage is identified, it should be reported immediately to the relevant authority.

Note

The actual tasks required to test the performance of the pendants will depend on the design of the system. In each case, the full range of performance characteristics should be covered. For example, some pneumatically controlled pendants have rotational as well as vertical movement, and this should be tested; the braking system (where applicable) and the fail-safe devices (such as remote controllers) should also be covered. The advice of the manufacturer should be followed.

Terminal units in all locations

10.161 Terminal unit probes, particularly those attached to high pressure hoses, can be ejected from the terminal unit with considerable force. Probes or other equipment should be restrained/supported during removal from a terminal unit to prevent damage or injury.

- | |
|---|
| <p>(i) Insert a blank probe and test for gas-specificity, ease of operation and leaks.
The probe should not swivel in a wall-mounted terminal unit but must be free to rotate in a pendant or boom-mounted terminal unit.
Replace the sealing capsule/valve and/or second-fix unit where necessary, taking care that the anti-swivel pin, visible through the terminal aperture, is in the 12 o'clock position.</p> |
| <p>(ii) Repeat test (i) and, if satisfactory, test the terminal unit for correct flow and pressure drop using a test instrument (see Table 12 in Part A for pressures to be achieved at defined terminal unit flow rates under design flow conditions).</p> |

Note

It will not be possible to ascertain actual system flow, or its proximity to design flow, unless system flowmeters are fitted. However, it is acceptable for the maximum pressure drops at terminal units specified in Table 12 in Part A of this Health Technical Memorandum to be used as test criteria.

11 Glossary of terms

Absolute pressure: The pressure with reference to absolute zero, that is, with reference to an absolute vacuum; it equals the sum of the atmospheric pressure and the gauge pressure.

Absolute zero: The lowest theoretically achievable temperature; the temperature at which all molecular activity ceases and pressure reduces to zero. Experiments have achieved temperatures within a few millionths of a degree Celsius of absolute zero. The point is taken as the reference zero for the absolute scale of temperature, measured in degrees Kelvin (or K). (0°C is approximately 273 K.)

Access (engineering): Extent of space (walkway, passage, surrounding plant etc) to allow delivery/transport of cylinders, plant maintenance etc.

Access (general): The extent to which people are able to receive the information, services or care they need.

Activated carbon/charcoal filter: Activated charcoal is often used to remove odours from compressed-air systems. An activated charcoal element is often incorporated with the **bacteria filter** in a medical air system.

Active (AGSS): As part of an MGPS, an active AGS system is one in which air-flow is generated by a pump (usually of the centrifugal type). Air-flows in the system depend on the design standard. Older BS 6834 systems have a flow rate range of 80–130 L/min, and BS EN 737-2 systems a range of 25–50 L/min.

Patients are interfaced to the system via a receiver (sometimes called an air break), which effectively prevents the high system flows from being connected directly to the patient.

The term “active system” is also applied to dental gas scavenging systems employing a dual concentric nose mask through which air flows at a (usual) maximum flow rate of 45 L/min. The flow source is usually the dental vacuum system, which usually generates much higher flow rates (typically up to 300 L/min). A flow reducer is used between the source and the mask to provide the correct flow.

Such a mask will be useless if connected to a normal MGPS active system and will result in severe spillage of waste anaesthetic gases.

Adiabatic: Expansion or compression of a gas without loss or gain of heat content.

After-cooler: A heat-exchanging device used to cool and hence release water by condensation from compressed air. It is usually mounted in the output pipework from a compressor.

AGSS: See **Anaesthetic gas scavenging system**.

Alarm signal status unit: A small indicator panel affixed to all major plant items and displaying normal and fault operating conditions. It mimics the relevant column on the central alarm display panel.

Alarm system: A series of interconnected, electronically operated units that continually monitor pipework pressure and plant operating conditions and relay these to appropriate personnel via coloured indicator display panels.

Allowable pressure drop: The maximum permissible pressure drop when a medical gas system is delivering its full **design flow**.

Amal: A trade name of a company that once produced calibrated orifices for use in flow generating/measuring devices. Such jets were given numbers representative of the diameter of the orifice. Although the company is no longer trading, “Amal jets” can still be obtained from other suppliers.

Anaesthetic agent: A drug used to reduce or abolish feeling.

Anaesthetic gas scavenging system (AGSS): A complete system which conveys expired and/or excess anaesthetic gases from the **breathing system** to the exterior of the building(s) or to a place where they can be discharged safely, for example to a non-recirculating exhaust ventilation system.

AGSS are classified as **active**, **passive** or semi-active/semi-passive.

Analgesic drug: A drug used to reduce or abolish pain.

Area valve service unit (AVSU): A valve assembly within an enclosure provided for maintenance, for connecting a temporary supply, for shutting off the gas flow to a specific area in an emergency, or for the purging and testing of gas supplies after engineering work. Sometimes called a zone service unit.

As-fitted drawings: Scale drawings of a pipework system which shows the exact positions of pipework, valves etc with respect to the layout of the building in which the system is fitted.

Atmospheric dew-point: See **Dew-point**.

Authorising Engineer (MGPS): A person with suitable qualifications (for example chartered engineer or incorporated engineer) and sufficient relevant experience to oversee and audit a number of medical gas systems and their associated **Authorised Persons (MGPS)**, and who can offer expert technical advice to MGPS managers and users. He/she will also be responsible for recommending Authorised Persons (MGPS) for appointment and ensuring that sufficient Authorised Persons (MGPS) are appointed for each hospital within their area of responsibility.

Authorised Person (MGPS): A person who has sufficient technical knowledge, training and experience in order to understand fully the dangers involved, and who is appointed in writing by the Executive Manager on the recommendation of an **Authorising Engineer (MGPS)**. The certificate of appointment should state the class of work that the person is authorised to initiate and the extent of his/her authority to issue and cancel **permits-to-work**.

The Authorised Person (MGPS) should have read, have understood and be able to apply the guidance in this Health Technical Memorandum, especially in relation to **validation and verification**, and should also be completely familiar with the medical gas pipe routes, their means of isolation and the central plant. He/she should ensure that the work described in any permit-to-work is carried out to the necessary standards.

AVSU: See **Area valve service unit**.

Backflow: Flow in a direction contrary to the intended normal direction of flow.

Bacteria filter: The final stage of filtration in a medical air system, usually placed before the pipework **pressure regulator** and often constructed with an integral **activated charcoal filter**, which is used to aid odour removal. For a medical air system, such a filter will be specified to an efficiency of 99.9999% according to the **DOP** (aerosol) test.

Albeit filtered to this degree, medical air is not considered sterile.

Batch number: A distinctive combination of numbers and/or letters that specifically identify a batch or lot, and permit its history to be traced (for example the batch number on a medical gas cylinder).

Bodok seal: A type of (high pressure) gas seal featuring a (neoprene) rubber flat-disc washer bonded to an outer alloy ring. Such seals are commonly used in connections of medical gas cylinders to manifold systems and other equipment using **cylinder yokes**.

Bourdon tube: A curved metal tube (sealed at one end) that flexes to a known degree when pressurised internally.

Boyle's Law: One of the **Gas Laws** relating volume and pressure: at a constant temperature, a change in pressure of a gas results in an inverse change in its volume.

Brazing: A **jointing** technique using heat and a non-ferrous **filler metal** (more specifically, brass) to effect a joint between metal components. The filler metal has a melting point below that of the base metals. Parts being joined fit fairly close together, and the filler is distributed by capillary action. The joint is produced by the bonding action of the filler metal.

Breathing system: A gas pathway in direct connection with the patient through which gas flow occurs at respiratory pressure and into which a gas mixture of controlled composition may be dispensed. The function of the breathing system is to convey oxygen and anaesthetic gases to the patient and remove waste gases from the patient. **Scavenging** equipment is not considered part of the breathing system. Also referred to as breathing or patient circuit, respiratory circuit or system.

Breathing system – semi-closed: A system that allows some of the expired gases to leave the circuit; the remainder mixes with fresh gases and is rebreathed. A **carbon dioxide absorber** is used in this system.

British Compressed Gases Association (BCGA): The British Compressed Gases Association seeks to promote safe practice in the manufacture, distribution, storage and use of compressed and liquefied gases.

The Association represents:

- manufacturers and suppliers of bulk liquid and cylinder gases;
- manufacturers and suppliers of cylinders vessels and tanks for storing and distributing cylinders;
- manufacturers and suppliers of equipment for controlling the application and use of gases;

- installers of distribution pipework and systems;
- providers of specialist safety, health, quality, inspection and training services.

Buffer vessel: A reservoir used to smooth out variations in pressure caused by varying demands in a **pressure swing adsorber (PSA)** system.

Bull-nose valve: A type of cylinder valve in which connection of equipment is effected via a threaded valve outlet.

Bursting disk (frangible disk): A metal disk that is part of a safety device and is intended to burst and allow gas to escape within predetermined pressure limits to prevent rupture of the device on which it is installed. It is similar in function to a safety relief valve. However, it has no reseating capability.

Cannula: A (usually) hand-held hollow tube designed for insertion into a body cavity. It may be attached to a vacuum system for purposes of fluid/detritus removal.

Capillary fitting: A pipeline-joining **component** (for example **tee**) of which the inside diameter (that is, that into which the pipe has to fit) is only slightly larger than the outside diameter of the pipe itself. Hence, during the **jointing** process, hot **filler metal** will be drawn into the joint by capillary action. For this reason, they are often known as “end feed” capillary fittings.

Carbon dioxide absorber (circle absorber): A device used to remove carbon dioxide chemically from exhaled patient gas. Primarily used in closed or semi-closed circle **breathing systems**, which require carbon dioxide removal to make rebreathing possible.

CCU: Coronary care unit.

CE mark (of medical products): A CE mark applied to a product means that the manufacturer is demonstrating that the product complies with relevant European Directive requirements, essential for it to be safe and fit for its intended purpose.

Charles’s Law: One of the **Gas Laws**: at a constant pressure, the volume of a gas changes by $1/273$ of its volume at 0°C for every 1°C change in its temperature; that is, at constant pressure, its volume is directly proportional to its absolute temperature.

Check: To make a thorough inspection for damage, wear or deterioration. Also to ascertain that the plant or equipment is correctly adjusted to conform to the required standard.

Check valves: Also known as unidirectional valves, non-return valves or one-way valves, these units allow passage of a gas or liquid in only one direction.

Clinician: Professionally qualified staff providing clinical care to patients.

Competent Person (MGPS): A person having sufficient technical knowledge, training and experience to carry out his/her duties in a competent manner and understand fully the dangers involved, and whose name is on the register of Competent Persons (MGPS). The register should be maintained either by a specialist **contractor** or by the **Authorised Person (MGPS)**.

He/she should be familiar with and able to read the record drawings and should have received specific training on MGPS.

He/she should be able to identify all types of medical gas **terminal units** and should be familiar with all testing and commissioning procedures referred to in this Health Technical Memorandum.

The person maintaining the register should assess a person’s competence, taking account of his/her training and experience.

Competent Person (Pressure Systems): A full list of the attributes required is given in the Pressure Systems Safety Regulations 2000. In summary, minor systems require a Competent Person (Pressure Systems) of at least incorporated engineer status, while intermediate and major systems require chartered engineer status.

Component: One of the gases in a mix. A constituent of a gas mixture: either “minor component” or “balance”. A two-component gas mixture consists of one minor component and a balance material. There is no such thing as a one-component mixture – this is referred to as a “pure” gas or material.

Compound: A term used to describe a usually locked, fenced area housing a **vacuum-insulated evaporator (VIE)** installation. In chemistry a compound is a substance formed by the combination of atoms.

Compression-type fitting: A method of pipe **jointing** using a special fitting which, when tightened manually, causes the compression of a soft metal ring (usually called an olive) fitted over the pipe to effect a seal between the pipe and the body of the fitting. In some types of compression fitting, the seal is effected by crimping a special elastomeric seal (usually contained within a metal former) to the pipeline.

Concentration: The relative quantity of a **component** in a gas mixture. The ratio or proportion of a given component to the total quantity of gas mixture. The ratio is expressed in terms of concentration units (that is, as a percentage or in parts per hundreds, parts per million or parts per billion) and **concentration basis** (that is, mol/mol, weight/weight). For example: 10 ppm nitric oxide in

a balance of nitrogen mol/mol means that there are ten moles of nitric oxide per million moles of total mixture of nitric oxide and nitrogen.

Concentration basis: The basis for the units of **concentration** and the basis or “counting” units for expressing the ratio of a **component** to the total gas mixture (that is, mole per mole (abbreviated as mol/mol), weight per weight (abbreviated as w/w), or volume per volume (abbreviated as v/v)).

Example: A certificate of analysis stating “Component X: 100 ppm $\pm$ 2% (mol/mol)” means “for every 1,000,000 moles of mixture contained within this gas cylinder, 100 moles (no less than 98, no more than 102) are Component X”.

Contaminant: An undesired **component** in a pure gas or gas mixture.

Contamination:

- a. **of a (dental) water supply:** changes to the nature of the water and/or deterioration of the quality of the water supplied by the water supplier, whether it be harmful to health or not.
- b. **of a medical/dental gas supply:** changes in the physical or chemical composition of a medical gas or gas mixture such that it no longer meets Ph. Eur. specifications (or this Health Technical Memorandum’s requirements for dental air).

Continuous (or periodic) positive airway pressure (CPAP): Spontaneous breathing mode in which airway pressure remains positive throughout inspiration and expiration. A positive pressure reference is always maintained between breaths.

Contract: The agreement concluded between the trust and the **contractor**, including all specifications, contractor’s samples, plans, drawings and other documentation that are incorporated or referred to therein.

Contractor: The contractor commissioned typically as a subcontractor for the installation of the MGPS under the Standard Form of Building Contract issued by the Joint Contracts Tribunal 1980 (JCT 80). All contractors working on MGPS and DAVS should be registered to BS EN ISO 9001, with scope of registration defined as appropriate.

Contractor’s representative (CR): The person nominated by a **contractor** to oversee the installation of an MGPS. This may be a contractor’s project manager. The CR should have received training appropriate to the work under his/her control.

Contract supervising officer (CSO): The person authorised by the hospital authority to witness tests and checks under the terms of **contract**. He/she should have specialist knowledge, training and experience of MGPS and this Health Technical Memorandum.

Control panel: A term usually applied to the pressure-reducing and monitoring unit used with a **vacuum-insulated evaporator (VIE)**. The term is also attributed to the gas supply-switching unit of an automatic **manifold** system and to the electrical control units of compressors and vacuum plants.

Control valve: An isolating valve mounted in a medical gas pipework and which is usually used for engineering purposes. These valves are usually mounted in ceiling voids, ductwork and plantrooms. They may be locked in their normal working position.

Corrosive (gas/liquid): Any gas/liquid that chemically attacks materials with which it comes into contact (that is, metals or skin).

CPAP: See **Continuous (or periodic) positive airway pressure**.

Creep: An increase in outlet pressure occurring after the regulator pressure has been set. Creep normally appears as a gradual rise in outlet pressure over a period of time. The usual cause of creep is **contamination** in the regulator seat causing the regulator to remain slightly open, leading to an increase in outlet pressure.

Critical care area/critical care facility: The Department of Health (DH) now does not differentiate between the terms “intensive care units” (ICUs) and “intensive therapy units” (ITUs). The generic terms “critical care areas” and “critical care facilities” have been adopted by DH to describe such units.

Cross-border SHA: A special health authority performing functions in respect of both England and Wales.

Cross-connection: Any connections between two or more medical gas services or between a medical gas service and any other piped service.

Cryogenics: The science of low temperatures, specifically, those below -40°C .

Cryogenic liquid system (CLS): A source of supply containing liquefied gas stored under cryogenic conditions. Usually used to describe bulk (rather than **liquid cylinder**) systems. (See also **Vacuum-insulated evaporator (VIE)**).

Cylinder yoke: See **Yoke**.

Decanting: The act of transferring a gas (usually oxygen) under pressure, normally from a large cylinder to a smaller (usually transportable) one. This procedure should not be carried out on NHS premises.

Design flow: A calculated value of gas flow which allows for flow diversity factors and which is used in estimation of primary gas source capacity.

Designated Medical Officer (MGPS) and Designated Nursing Officer (MGPS): The medical or nursing officer designated by the chief executive to act as a focal point for communications related to MGPS in a specified department or departments. There would ideally be a Designated Medical Officer (MGPS) and a Designated Nursing Officer (MGPS) in each department. These Designated Officers give permission for any interruption to the MGPS.

Designated Porter (MGPS): A suitably trained person who has been given responsibility for a particular operation involving medical gas cylinders, for example responsibility for changing cylinders on the MGPS **manifold**.

Designated Senior Officer: A person with suitable management and technical experience to act as a liaison officer on matters concerning the MGPS at trust board level. He/she will work closely with the **Authorising Engineer (MGPS)** and **Authorised Person (MGPS)**.

Design pressure (maximum allowable pressure): The pressure at which a **pressure safety valve** starts to lift.

Dew-point: The temperature to which air must be cooled in order to be saturated with respect to water at its existing pressure. Although dew-point sensors on medical compressed-air plant are often sited in the high pressure air leaving the dryer columns, medical compressed-air dew-points from such plant are always quoted in terms of the dew-point of the air as if it were at atmospheric pressure (that is, an atmospheric dew-point).

Distributor: A pipeline that traverses a building (usually horizontally) taking gas from a **riser** to a **drop**. Distributors are usually connected to risers via **line valve assemblies (LVAs)** or **area valve service units (AVSUs)**.

Diversity: When calculating medical gas flows from, say, a ward area, an allowance is made for the fact that it would be exceedingly unusual for all terminal units to be in use simultaneously. This allowance is called a diversity factor and, for flow calculation purposes, will give a flow value for a particular area that is less than the mathematical (algebraic) sum of the flows from all the terminal units.

DOP: Dioctylphthalate. A **compound** of accurately controllable particle size used in the efficiency testing of filter media. This test has generally been replaced by a Dispersed Oil Particulate test (also using the DOP acronym), which is an aerosol test.

Drop: A term used to describe the (usually short) vertical run of pipe from a **distributor** to a **terminal unit**.

Duplex plant: Two identical plant items (for example vacuum pumps). One is the “duty” or working plant, the other is the “stand-by” plant, which will come on line automatically in the event of failure of the duty plant. BS EN 737-1 identifies a duplex system as primary and secondary supply sources.

Earth bonding (on an MGPS): A low resistance electrical connection between the copper pipework and an electrical earth conductor. Also used to describe electrical continuity connection across flexible (non-conductive) couplings on plant (for example between the pump output port and copper exhaust lines on a medical vacuum plant) or any electrical connection to earth of parts of plant, alarm systems etc.

Elbow: A pipe fitting that provides a preformed angled joint without having to resort to bending of the normal pipework run. Elbows are presented according to the angle of their bend (for example a 90° elbow) and are available as **capillary** or **compression**-type fittings.

Emergency inlet port: A (usually gas-specific, but this may not be possible in high flow applications) connector allowing connection of emergency gas supplies to medical air or oxygen systems in the event of a major gas failure (for example primary and secondary supplies).

Emergency supply/reserve manifold – ESM/ERM: A manifold used as an alternative means of supply for a medical gas supply source (for example the automatic **manifold** supporting a duplex medical air compressor system).

The term ESM also refers to additional manifolds that have been added to an MGPS to protect against supply failure arising from such events as pipeline fracture.

ESMs/ERMs can be manual or automatic:

- a manual ERM/ESM (that comes on line automatically in the event of failure of an automatic manifold (primary) supply and is connected into the system pipeline via a non-return valve) is usually specified as secondary support for an automatic manifold;
- an automatic ERM/ESM is specified for a medical air compressor, **oxygen concentrator** or **cryogenic liquid system**, where the latter is

a single vessel primary supply or a **liquid cylinder** system. (Currently, many manual manifolds are employed as support for single cryogenic liquid vessels and liquid cylinder systems.)

English NHS body: A **primary care trust**, **strategic health authority** or NHS **trust**, all or most of whose hospitals, establishments and facilities are situated in England, or an NHS **foundation trust** or special health authority performing functions only or mainly in respect of England.

Entonox: BOC (British Oxygen Company) trade name for a 50/50 mixture of nitrous oxide and oxygen. Used for pain relief. (See also **Equanox**.)

Equanox: Linde (gas producer) trade name for a 50/50 mixture of nitrous oxide and oxygen. Used for pain relief. (See also **Entonox**.)

Equipment: A device, such as a pressure regulator and flowmeter, which is connected to a single cylinder for the administration of medical gas to an individual patient or gas apparatus.

Equivalent length: The resistance to flow, in terms of a length of pipe of the same diameter, caused by insertion of a fitting; for example, inserting a ball valve into a 22 mm diameter pipe gives rise to a flow resistance equivalent to 0.6 m of straight pipe: 0.6 m is the equivalent length of the valve.

ERM: See **Emergency supply/reserve manifold**.

ESM: See **Emergency supply/reserve manifold**.

Essential supply: An electricity supply intended to be maintained in the event of failure of the main supply. It is usually provided from an on-site emergency generator. Medical gas systems and alarms should be connected to the essential supply.

Evaporator: A heat-exchanging device in the cryogenic liquid output line from a **vacuum-insulated evaporator (VIE)**, in which liquid product boils under constant pressure, at atmospheric temperatures, to produce gas.

Examine: To make a careful and critical scrutiny of an item without dismantling by using the senses of sight, hearing, smell and touch in order to verify that the plant or equipment is in working order.

Filler metal: The special alloy used during a **brazing** process which effects a joint between the materials being brazed (for example copper pipeline components).

Firecode: Department of Health publication detailing fire prevention measures in healthcare premises.

First-fix: The gas-specific back part of a **terminal unit**. It contains an automatic isolating valve.

Flammable: Capable of burning with a flame.

Flammable limits: The upper and lower concentration limits for a flammable gas, above and below which flame propagation does not occur on contact with a source of ignition. Flammable limits are calculated at ambient temperature and pressure in the air.

Flammable material: A gas, vapour, liquid, dust or solid that can react continuously with atmospheric oxygen and that may therefore sustain fire or explosion when such reaction is initiated by a suitable spark, flame or hot surface. In normal usage, “gas” and “vapour” are synonymous.

Flammable mixture: A mixture of gas, mist or suspension of dust with air (or air enriched with oxygen) in which combustion will propagate.

Flammable range: The range of concentrations in air of a flammable material within which combustion can occur.

Fluid: Any material or substance that changes shape uniformly in response to an external force imposed on it. The term applies to liquids, gases and finely divided solids.

Flux: Material used to clean and shield **components** susceptible to atmospheric oxidation during a hot **jointing** process. Borax-based fluxes are commonly used when jointing using **silver solder**.

Fluxless brazing technique: See **Jointing**.

Foundation trust: a public benefit corporation established by the Health and Social Care (Community Health and Standards) Act 2003 which is authorised to provide goods and services for the purpose of the health service.

Free air/free air delivered (FAD): Free air is air at the atmospheric conditions at the inlet point of a compressor. The output of an air compressor is often referred to using the stated atmospheric conditions at the inlet, for example 500 L/min free air delivered (FAD).

The letters ANR placed after a rate of air-flow expressed in L/s or m³/h indicate that free air-flow is being expressed. ANR = Atmosphère Normale de Référence.

Fusible plug: A device fitted in the hot discharge zone of a compressor, or on a compressed-air receiver, for protection against high temperature.

Gas Laws: Mathematical laws describing the behaviour of gases in response to changes in temperature, pressure and volume. See also **Charles's Law** and **Boyle's Law**.

Gauge pressure: The pressure as measured with reference to atmospheric pressure. Where no other indication is given, pressures expressed in “bar” are assumed to be gauge pressures.

Governance: A mechanism to provide accountability for the way an organisation manages itself.

Hazard level: The term used to describe the level of risk to a patient served by an MGPS when work on that MGPS is taking place. In this Health Technical Memorandum, two hazard levels are defined: high and low. Either of these will be used to define the type of permit used to manage the MGPS work. (See also **High hazard work** and **Low hazard work**.)

Hazardous area: An area in which flammable or explosive dust–air mixtures (also gas/vapour–air) are, or may be expected to be, present in quantities such as to require special precautions against ignition.

Healthcare: Services provided for, or in connection with, the prevention, diagnosis or treatment of illness and the promotion and protection of **public health**.

Healthcare-associated infection: All infections acquired as a direct or indirect result of healthcare.

Healthcare organisation: **English NHS bodies**, **cross-border SHAs** and other organisations and individuals, including the independent and voluntary sectors, which provide or commission healthcare for individual patients and the public.

Health Technical Memorandum 22: This document was first published by the Department of Health and Social Security in 1972, amended by HN ((76) 175) and last reprinted in 1978 with minor corrections.

Health Technical Memorandum 2022: Health Technical Memorandum 2022 (1997) began life as **Health Technical Memorandum 22**, was published in 1974 and revised in 1994. It is now superseded by Health Technical Memorandum 02.

There are two supplements to this publication:

- ‘Dental compressed air and vacuum systems’; and
- ‘Medical gas systems for ambulances’.

These supplements now support this Health Technical Memorandum.

High hazard work: A term used in the MGPS **permit-to-work** system to define the level of risk to patients caused by work on an MGPS which involves introducing the possibilities of **cross-connection** and pollution (for example cutting and **brazing** pipework).

Hospice: An organisation, often charitably funded, in which multidisciplinary teams strive to offer freedom from pain, dignity, peace and calm at the end of life. Hospices encompass a range of services – pain control, symptom relief, skilled nursing care, counselling, complementary therapies, spiritual care, art, music, physiotherapy, reminiscence, beauty treatments and bereavement support. All care is free of charge.

Hygrometer: A device for measuring the water vapour content of a gas sample. It may output its reading as a **dew-point**, **relative humidity** or water content.

Hyperbaric chamber: A medical treatment device in which a patient is subjected to (usually) elevated concentrations of oxygen at a pressure above atmospheric. Blood oxygen levels and oxygen exchange rates are increased.

ICU: Intensive care unit (analogous to **Intensive therapy unit (ITU)**).

Impurity: An additional or extra component of a pure gas or gas mixture. Impurities are most commonly encountered in pure material used as the raw material source for a **component** of a gas mixture. An impurity may be removed by purification. Alternatively, the impurity may be measured and accounted for during blending, thereby preventing it from becoming a **contaminant**.

Intensive therapy unit (ITU): See **Critical care area/critical care facility**.

Joining (of medical gas pipelines): Medical gas pipelines comprising copper are joined using a special fluxless brazing technique in which an inert gas (**oxygen-free nitrogen**) is used to shield the components of the joint and the **filler metal** from oxidation during the heating process. Typically, temperatures in the region of 650–950°C are used for the joining process.

Cold joining processes such as flanges, screwed and **compression-type fittings** and axially swaged fittings can be used, provided that they do not contain elastomeric materials and have a fire resistance at least equal to that specified in ISO 7396-1 (600°C without leakage).

Medical vacuum or **anaesthetic gas scavenging system (AGSS)** pipelines comprising plastic materials may be ultrasonically or solvent-welded. Dental compressed-air nylon pipelines may be assembled using compression-type fittings.

Kelvin: The Kelvin (K) is the SI unit of temperature and is one of the seven SI base units. It is defined by two facts: zero Kelvin is absolute zero (when molecular motion stops), and one Kelvin is “the fraction $1/273.16$ of

the thermodynamic temperature of the triple point of water” – the point at which water, ice and water vapour exist in equilibrium.

The temperature 0 K is called absolute zero and corresponds to the point at which the molecules and atoms have the least thermal energy.

The Celsius temperature scale is now defined in terms of the Kelvin, with 0°C corresponding to 273.15 Kelvins, approximately the melting point of water under ordinary conditions.

As an approximation, degrees Celsius can be converted to degrees Kelvin by adding 273.

LDRP: Labour, delivery, recovery and post-partum.

Line valve assembly (LVA): A pipeline-isolating valve fitted to facilitate maintenance of an MGPS. This Health Technical Memorandum recommends that all LVAs should be locked in their normal operating positions, unless sited in a locked plantroom. LVAs are not normally enclosed in locked boxes and will not have the benefits of **non-interchangeable screw thread connector (NIST)** fittings. These are often sited in ducts.

Liquid cylinder: A small-scale (typically 200 L, but also up to 800 L – often nicknamed a “mini-VIE”) cryogenic liquid storage vessel, usually used for storing liquid oxygen where large-scale storage is unnecessary. The cylinders are usually manifolded in parallel and are refilled via a common (usually externally-terminated) filling pipeline.

Evaporator coils are fitted within the vessel and absorb heat via thermal transfer through the vessel’s external stainless-steel shell.

The main advantages of a liquid cylinder installation are:

- less demanding accommodation requirements (for example they may be sited in a manifold room); and
- capacity (for example, a BOC LC200 unit holds the equivalent of approximately 24 J-size, 137 bar cylinders).

Local area alarm: An alarm indicator unit sited in areas of (usually) high dependency and used to signal high or low medical gas pipeline pressures to local staff.

Low hazard work: One of the two classifications of hazard level pertaining to work on a medical gas system. Low hazard work is work that carries no risk of cross-connection or pollution of the gases delivered to the patients. It encompasses all work other than **high hazard work**.

LVA: See **Line valve assembly**.

Magnetic resonance imaging (MRI): MRI is a method of obtaining cross-sectional images (slices) of internal soft body tissue. It is primarily used to demonstrate pathological or other alterations in this tissue. The technique allows greater accuracy in the diagnosis of neurological conditions such as multiple sclerosis.

Main cylinder storage area: The main area where all cylinders on a site are stored, excluding only those cylinders in, or for immediate use in, **manifold rooms** or in **ready-to use stores**.

Manifold (automatic): A device that allows connection of high pressure gas cylinders to a medical gas system. It comprises a control panel which reduces the pressure to its working value, an automatic changeover facility (empty to full cylinders) and alarm indicators. Automatic manifolds are designed such that they will continue to supply gas in the event of an electrical supply failure.

Manifold (manual): A manifold that requires manual intervention to initiate a changeover from empty to full cylinders.

Manifold (semi-automatic): A manifold that will change from empty to full cylinders automatically but will require manual resetting when new cylinders are installed.

Manifold control unit: A cased assembly of components controlling the pressure and delivery of gas, alternately, from two banks of cylinders. It may be totally mechanical in operation or contain electronic and/or electrical components. Whatever method of operation is chosen, a medical gas manifold must continue to supply gas in the event of an electrical failure.

Manifold room: A purpose-built room designed to accommodate a cylinder manifold installation and reserve cylinders as appropriate.

Maximum pressure drop: The maximum allowable pressure difference in a medical gas pipework between plantroom outlet and point of use. For example, the maximum pressure drop allowed in a medical vacuum system at a nominal plantroom outlet pressure of 450 mm Hg is 50 mm Hg between the plantroom and the back of the most remote **terminal unit** (under dynamic conditions).

Individual terminal units and flexible hoses will also have maximum allowable pressure drops at flow rates determined by design parameters and defined in the appropriate design standard(s).

Maximum working pressure: A pressure to which the vessel or system may be continuously exposed without detrimental effect on any **component**. In order to avoid

unwarranted operation of the **pressure-relief valve**, the maximum working pressure should not exceed 92.5% of the **design pressure**.

Medical device: Any product, except medicines, used in healthcare for diagnosis, prevention, monitoring or treatment. The range of products is very wide: it includes contact lenses and condoms; heart valves and hospital beds; resuscitators and radiotherapy machines; surgical instruments and syringes; wheelchairs and walking frames.

Medical gas: Any gas used in a regime of patient therapy and defined as a medicine under the Medicines Act 1968.

Medical gas pipeline system (MGPS): The fixed medical gases pipework, the associated supply plant or pumping equipment, and the warning and alarm systems. This definition includes medical compressed-air, medical vacuum installations and **anaesthetic gas scavenging systems (AGSS)**.

Medical supply unit: Prefabricated, permanently installed equipment intended to supply electric power and/or medical gases and/or liquids. Booms, ceiling pendants, wall systems and bedhead trunking systems are typical devices of this kind.

MGA: UK Medical Gas Association. An organisation representing the interests of all working with, or having an interest in, medical gases and their applications.

MHRA: Medicines and Healthcare products Regulatory Agency. The Agency replaced the Medical Devices Agency (MDA) and the Medicines Control Agency (MCA) in 2003.

Minimum leak device: A small orifice permanently fitted in a pipework and used as a connection point for control devices (for example **pressure switches**). The device allows removal and repair/refitting of the switch without supply interruption.

Mole: For a given molecule, one mole is the mass numerically equal to its **molecular weight**. A gram mole is the mass in grams equal to the molecular weight. A pound mole is the weight in pounds equal to the molecular weight.

Molecular sieve: Any compound capable of selective adsorption of gas molecules (for example the **zeolites** used in **pressure swing adsorber (PSA)** plant).

Molecular weight: The sum of the atomic weights of all the constituent atoms in a molecule.

Monograph: A detailed description of a medicine, its composition, allowable impurities, methods of analysis etc contained in a **Pharmacopoeia**.

Muting: Silencing on a temporary or permanent basis of the audible alarm on a medical gas alarm system.

Nominal pipeline distribution pressure: The pressure in a pipework under **design flow** conditions. For medical gases in the UK, the nominal distribution pressure is 400 kPa, except for surgical air which may have distribution pressures between 700 kPa and 1100 kPa. Medical vacuum has a nominal pressure of 450 mm Hg (60 kPa) below atmospheric.

Non-interchangeable screw thread connector (NIST): A gas-specific connector used as a termination for flexible hoses and copper pipe in a ceiling plate etc. Despite the name, it is the dimensions of the male part of the connector that make it gas-specific, not the outer screw-threaded fastening ring.

Normal cubic metres per hour (Nm³/hr): Flow rate where a normal cubic metre is the volume of a gas measured at **normal temperature and pressure**.

Normally closed: Usually used with reference to valves or electrical contacts, and indicates the normal operational state of the valves or contacts.

Normal temperature and pressure (NTP): A gas industry reference base: 20°C and 760 mm Hg. (Some calculations use alternative references of 15°C or 25°C.)

Normal working pressure: A pressure less than the **maximum working pressure** at which the system actually operates.

Oxygen concentrator: See **Pressure swing adsorber (PSA)**.

Oxygen-free nitrogen: A gas recommended for use as an inert shield purge during the hot **jointing** of copper medical gas pipework. It obviates the need to use **flux**. It is often referred to as “white spot nitrogen” as a result of the cylinder colour scheme (a white spot on the black shoulder of the cylinder (which has a grey body) – this has now been superseded by a grey-bodied cylinder with a black top, but no white spots).

Parts per million (ppm): A measurement usually applied to concentrations of gases etc in other gases, gases in liquids, liquids in liquids etc. Units can be volumetric or gravimetric. In the former, the terms volume parts per million (vpm or ppmv) are used to define units of measurement.

Passive system: A reference to a type of **anaesthetic gas scavenging system (AGSS)** in which there is no active element, that is, pump. Waste gases are propelled through the system by patient exhalation or the exhaust function of a patient ventilator.

In its simplest form, a passive system is simply a tube connecting the patient or patient ventilator to the outside air. Such a system is usually protected by positive and negative **pressure-relief valves** and is often equipped with a condensation trap.

Flow rates in such systems are by their nature low and subject to back pressure effects arising from local wind conditions at the outside terminal, or excessive lengths of discharge hose.

If used with flammable agents, the potential for flashback is high, and the terminal is often fitted with meshes to lower this risk and the effects of wind pressure.

Patient: Those in receipt of healthcare provided by, or for, an **English NHS body** or **cross-border SHA**.

Peak flow: The likely flow through a medical gas system under conditions of maximum demand.

Pendant: A mechanical device, usually ceiling-mounted in an operating theatre, and designed to facilitate easy access to medical gas and electrical supplies. It may be a fixed unit (a rigid pendant), a telescopic pendant (a variation on the rigid unit in which some vertical movement (usually motor-driven) of the pendant is possible) or a complex unit in which movement in all planes is possible. A single, ceiling-mounted hose is also often called a pendant.

Permit-to-work: A form of declaration, or certificate, in five parts, used to control work on a medical gas system.

Its objective is to prevent inadvertent isolation of, or unauthorised work on, the gas system.

It states the degree of hazard involved and defines all services to be worked on and the points where isolation of the affected sections are to be carried out.

It also describes the work to be done and requires the signature of a **Designated Medical Officer (MGPS)** or **Designated Nursing Officer (MGPS)** before work on an MGPS is allowed to commence.

Permits are required for all work on an MGPS except:

- a. refilling of cryogenic storage vessels;
- b. replacement of cylinders on manifold systems;
- c. emergency isolation of a gas supply by a member of the medical/nursing staff;
- d. commissioning of new systems.

Pharmacopoeia – British (BP): A publication containing a compilation of pharmaceutical products with their formulas, methods of packaging, preparation and delivery etc. In a shortened form, the BP exists as the national formulary, which contains advice for practitioners on dosage, delivery, side-effects etc.

Pharmacopoeia – European (Ph. Eur.): European publication largely superseding the BP and containing 1800 specific and general **monographs**. It contains details of all types of active substances used to prepare pharmaceutical products.

Pin-index(ed) safety system (PISS): A method of ensuring gas-specific connections by the provision of interlocking pin/socket combinations. The pin position is defined for each gas service. Pin-indexing is used on many medical gas cylinder valves.

Pin-index valve: A medical gas (cylinder) valve constructed with an integral pin-index system: drilled into the valve body in positions defined by the gas contained in the cylinder are one or two sockets into which a corresponding item of pin-indexed equipment (for example a **cylinder yoke**) will fit. Such an assembly offers a gas-specific connection.

Pipeline carcass: The pipework installation with **terminal unit** base blocks and **area valve service units (AVSUs)** (excluding **pressure switches**, flexible assemblies etc) fitted.

Pipework manifold: A pipe to which cylinder **tail-pipes** are connected, which in turn is connected to the control equipment by means of which medical gas is delivered to the MGPS.

Pipework odour: Any odour resulting from internal **contamination** of the MGPS copper pipework (for example by a residual cleaning agent) or arising from the supply system. Odours may be detected when testing flexible hoses. These arise from plasticisers in the hose material, and are generally considered to be harmless to patients.

Planned preventive maintenance (PPM): A scheme of work contrived to attain maximum plant efficiency.

Premises: The premises should be the hospital site, healthcare building or other establishment where the MGPS is installed and the services are to be provided, as defined in the **contract**.

Pressure gas: A term applied to gases that are delivered at pressures above atmospheric. In the case of medical gases, pressure gases are oxygen, nitrous oxide, **Entonox/Equanox**, medical air, surgical air, nitric oxide and oxygen/carbon dioxide mixtures. With the exception of surgical air, which is distributed at pressures up to 1100 kPa, medical gases are distributed at a nominal pressure of 400 kPa.

Pressure regulator: A device used to control the operating pressure in a gas system.

Pressure-relief valve: See **Pressure safety valve**.

Pressure safety valve (pressure-relief valve): A type of valve designed to limit pressure within a pipework or other pressurised system. Medical gas pipework safety valves are usually set at 530 kPa on a 400 kPa system.

Pressure swing adsorber (PSA): Another term for an **oxygen concentrator**. It is an electromechanical system comprising air compressor(s), nitrogen adsorber unit(s) and a reservoir, by means of which oxygen-enriched air is generated from atmospheric air. The adsorption process usually depends on the use of **zeolites**.

Oxygen concentration in the product is normally below the 99.5% specified in the Ph. Eur. for medical oxygen: typically PSA oxygen concentrations range from about 96% to 99%, although to achieve the latter figure, the plant is generally expensive.

The plant is also designed to remove most of the water vapour and oil from the final product, which comprises a mix of (mostly) oxygen, nitrogen and argon.

PSA oxygen must be tested on a quarterly basis in accordance with QC routines applied to medical air produced by compressors.

Pressure switch: An adjustable electromechanical device in which varying pressures in a (medical) gas system activate electrical contacts and, hence, an alarm system.

(The) Pressure Systems Regulations (1989) (now replaced by the Pressure Systems Safety Regulations (2000) and the Pressure Equipment Regulations (1999)): In the regulations, three categories of pressure system are defined:

- a. minor systems: pressure less than 20 bar (2 MPa), and the pressure volume product for the largest vessel should be less than 2 x 105 bar L (20 MPa m³);
- b. intermediate systems: these include systems that do not fall into either of the other two categories;
- c. major systems: steam-generating systems exceeding 10 MW, and pressure storage systems in excess of 106 bar L (100 MPa m³).

Most MGPS and dental air systems fall into the minor systems category. Systems with a largest pressure vessel x working pressure product of less than 250 bar L are exempt from some of the regulations.

Primary care: First-contact health services directly accessible to the public.

Primary care trust: A local health organisation responsible for managing local health services. PCTs work

with local authorities and other agencies that provide health and social care locally to make sure the community's needs are being met.

Primary supply: The first operational supply of gas from a gas source (for example the duty pump of a duplex compressor plant).

Probe: A gas-specific connector used to connect equipment to a **terminal unit**. It is attached either to a hose (remote probe) or to a piece of equipment, for example a flowmeter (direct probe).

Procedure: A written method which has been drawn up by a person familiar with the system and the requirements of this Health Technical Memorandum, and checked by the **Quality Controller (MGPS)** or **Authorised Person (MGPS)**. It should be signed by both persons and be dated, and include a review date.

Public health: Public health is concerned with improving the health of the population rather than treating the diseases of individual patients.

Purge: To scour (a pipeline) of residual particulate **contamination** and/or unwanted gases/moisture by means of a high flow of (purge) gas. Medical gas pipelines are purged with **oxygen-free nitrogen** during the **jointing** process, medical air during particulate contamination removal and working gases immediately before final QC testing and patient use.

Quality assurance: A systematic process of verifying that a product or service being developed is meeting specified requirements.

Quality Controller (MGPS): A person appointed in writing by the Executive Manager on the recommendation of the chief pharmacist. The Quality Controller (MGPS) should normally be a pharmacist or other **suitably qualified person**, and should have specialist knowledge, training and experience of MGPS and this Health Technical Memorandum. The Quality Controller (MGPS) is responsible for the quality of the medical gases; his/her duties include carrying out the quality tests in accordance with the procedures specified in Chapter 15, Part A.

Ready-to-use store: A local subsidiary to the main store for a limited number of medical gas cylinders, usually cylinders for immediate use and one day's supply for reserve purposes. Also known as a satellite store.

Receiver: A specially strengthened vessel used to store compressed air and smooth out variations in pressure caused by compressor pumps and varying system demand.

Relative humidity: The ratio of the quantity of water vapour in a gas sample to that needed to saturate the sample at the same temperature and pressure.

Ring main: A pipeline system which begins and ends at the source so that every outlet has two possible routes of supply.

Riser: A pipeline that traverses a building vertically. A main riser is the primary pipeline from the gas source.

Risk management: This covers all the processes involved in identifying, assessing and judging risks, assigning ownership, taking actions to mitigate or anticipate them, and monitoring and reviewing progress.

Safety extra low voltage (SELV): A secondary circuit which is so designed and protected that, under normal and single fault conditions, its voltages do not exceed a safe value.

Satellite store: See **Ready-to-use store**.

Scavenging: The collection of excess gases from a patient's breathing circuit and removal of these gases to an appropriate place of discharge outside the working environment.

Scavenging system (also AGSS): An assembly of specific components that collects and removes excess anaesthetic gases released from a breathing circuit. There are three types:

- a. **active**, in which a pump is used to create a flow which carries the waste gases;
- b. **passive**, in which the patient or patient ventilator provides the driving force for the gas expulsion;
- c. **semi-active**, in which a small amount of flow in the scavenging system is generated, for example, by the room ventilation system.

SCBU: Special care baby unit.

Schematic drawing/diagram: A drawing of a pipework showing the general layout of the system. Exact positions of the pipework and components with respect to building layout are not shown. Schematic drawings are not usually scaled.

Secondary circuit: An electrical circuit which has no direct connection to primary power and derives its power from a transformer, converter or equivalent isolation device, or from a battery.

Secondary supply: The second source of supply of a medical gas (for example an automatic **manifold** system supporting a medical compressed-air plant).

Second-fix: The gas-specific front part of a medical gas **terminal unit**. It contains a self-sealing valve.

Services: This means the services and goods that the **contractor** is required to supply in accordance with the **contract**.

Shield gas: The gas used to provide an inert shield during the **brazing** of medical gas pipework (usually **oxygen-free nitrogen**).

Short-term exposure limit (STEL): The maximum concentration of a chemical to which workers may be exposed continuously for up to 15 minutes without danger to health and safety.

Silver solder: A metallic alloy containing a high proportion of silver (usually in combination with tin) used as a **jointing** material for copper (it will also work with other metals). It requires a **flux** to ensure that the joint is cleaned and protected from oxidation during the soldering process. Typically, a process temperature in the region of 750°C is required.

Simplex: A single plant item, for example one compressor used as a primary gas supply.

Sodium flame test: A method of testing filter element efficiency using a cloud of known size/range sodium chloride particles as the challenge medium.

Soldering: A process during which a metallic alloy, melted between clean metal surfaces, alloys with these and so forms a joint. For many years, medical gas copper pipelines were joined using **silver solder**. Unfortunately, this solder requires the use of a **flux** during the **jointing** process. Flux residues can lead to corrosive attack of the copper pipeline in the form of verdigris.

Star valve: A type of cylinder valve, usually fitted with integral regulator and low pressure ports for connection of medical equipment or hoses.

Static pressure: The pressure inside a pipework under zero flow conditions.

Statutory Instrument (SI): Statutory Instruments are the commonest form of subordinate legislation (also known as secondary or delegated legislation). They are made by or under powers conferred by or under statute on Her Majesty in Council or on a Minister, the National Assembly for Wales or other body or person, and provide the detailed regulations which implement Acts of Parliament. As such, they must always be *intra vires*; that is, they must be within the scope of the enabling power in the parent Act.

Strategic Health Authority (SHA): An SHA is responsible for:

- developing plans for improving health services in its local area;
- making sure local health services are of a high quality and are performing well;
- increasing the capacity of local health services so they can provide more services; and
- making sure national priorities are integrated into local health service plans.

Suction device: A passive entity that can only induce air-flow when connected to a suction machine.

Suction system: Active entity of dental equipment, including a suction machine (vacuum pump), which enables a flow to be induced which is designed to remove spray, liquids and solids from the mouth of a dental patient during treatment.

Suitably qualified person: The **Health Technical Memorandum 22** nomenclature for the **Quality Controller (MGPS)**.

Synthetic air: Medical “air” comprising a mixture of approximately 20% oxygen with 80% nitrogen. The air is synthesised (mechanically mixed) from the gases vaporised from cryogenic supplies of liquid oxygen and liquid nitrogen. A synthetic air system is able to provide a hospital site with synthetic air, oxygen and (surgical) nitrogen.

Systematic risk assessment: A systematic approach to the identification and assessment of risks using explicit risk management techniques.

Tail-pipe: A flexible connecting pipe that connects a medical gas cylinder to a medical gas **pipework manifold** via a gas-specific connector.

Tare weight: The weight of an empty gas cylinder (sometimes measured without cap and valve).

Tee: A **compression** or **capillary** fitting in the shape of a letter “T” and used to form a joint in a pipeline system.

Telemetry: An electronic processing unit that relays information on the contents and internal pressure of a **vacuum-insulated evaporator (VIE)** to the gas supplier via a telephone modem.

Terminal unit (TU): A gas-specific socket, usually wall- or pendant-mounted, which is used as a connection point between medical equipment and the medical gas pipework system.

Test: To operate the plant or equipment and/or use the appropriate testing instruments to ensure that plant or equipment is functioning correctly.

Test point: A **terminal unit** and lockable control valve connected to all main plant items and used to facilitate engineering and pharmaceutical testing of the plant.

Third means of supply: A term used to describe additional support for a medical gas system in the event of failure of the primary system and secondary supplies. A typical example would be provision of a fully automatic **manifold** system that is permanently connected to the hospital end of a main pipework from a **cryogenic liquid system** installation. Hence, failure of the primary and secondary plant, or the interconnecting pipework, would not immediately deprive the hospital of oxygen as the manifold (the third means of supply) would take over in these circumstances. Fitting of appropriate non-return valves is crucial to the operation of a third means of supply.

Time-weighted average (TWA): A way of expressing exposure such that the amount of time spent exposed to each different concentration level is weighted by the amount of time a worker is exposed to that level.

Toxic: Concerning the property of a material that may chemically produce injurious or lethal effects to humans.

Training (gas cylinders): Formal instruction in the safe handling and storage of gas cylinders and associated equipment to ensure that staff are aware of the dangers involved and will act accordingly.

Trap: A mechanical device that allows automatic drainage of (condensed) water from a pipework or compressed-air plant.

Trunking (also called bedhead/walling systems): Wall-mounted plastic or metal ductwork, usually with some aesthetic appeal, which carries services such as MGPS around a patient area.

Trust: This means the NHS trust, special health authority or other health authority as appropriate.

Two-stage pressure-reducing regulator: A gas regulator which reduces high pressure to low pressure, and controls the low or outlet pressure with two stages of pressure reduction. Used when more stability of operation is required.

Vacuum-insulated evaporator (VIE): A source of supply containing liquefied gas stored under cryogenic conditions. (See also **Cryogenic liquid system (CLS)**).

Validation and verification (of an MGPS): Processes for ensuring that the gas delivered to a patient by an MGPS is unaffected by its passage through the system, for whatever reason, and that the MGPS is capable of meeting the demands of the user as defined in the original system design.

Validation and verification involves both engineering and pharmaceutical testing of the MGPS and is not limited to the proving of new installations.

Valve tree: An arrangement of valves connected to a single gas feed pipe, allowing multiple connections, each capable of being isolated.

Vapour: This is the gaseous state of matter. Although vapour and gas are frequently used interchangeably, vapour often carries the connotation of gaseous matter in a state of equilibrium with identical matter in a liquid or solid state.

Vapour pressure: The pressure exerted when a solid or liquid is in equilibrium with its own vapour at a particular temperature.

Volume parts per million (vpm): See **Parts per million (ppm)** and **Concentration**.

WAGS: Waste anaesthetic gas system/scavenger/scavenging – same as **AGSS**.

Written scheme of examination: A document detailing frequency and degree of examination of a pressure system by a Competent Person, as defined by the Pressure Systems Regulations.

Yoke: A mechanical assembly, usually having integral gas-specific components (for example the pins of a pin-index system), for attaching a compressed (medical) gas cylinder to a piece of equipment (for example an anaesthetic machine or a system supply **manifold**).

Zeolite: A microporous crystalline solid. Because of its unique porous properties, one of its main uses is in the separation and removal of gases and solvents. In an **oxygen concentrator**, air is passed into a column containing the zeolite. During its passage through the compound, the larger molecules of nitrogen in the air are absorbed into the zeolite, while the smaller molecules of oxygen pass through. The process is not 100% efficient, the concentration of oxygen leaving the column being about 96%. **Impurities** include nitrogen and inert gases, principally argon.

Zeolites are often referred to as **molecular sieves**.

Appendix A – Preparing an operational policy

General

1. **Appendix B** contains the essentials of an operational policy, although this will require expansion and modification to suit individual events.
2. It must be appreciated that there will be many ways to construct a policy, and the example in **Appendix B** is just one of these.
3. However, the advice given in these Appendices will help provide a basic policy structure.

Signatories

4. It is essential that the policy is acceptable to the Executive Manager, and he/she should signify this on the policy document.
5. Other signatories will be required, principally those personnel involved in the preparation of the policy, or at least members of the medical gas committee.

Circulation

6. The medical gas committee should agree circulation of the document. This will depend to a certain extent on the content of the document, and some thought should be given to how the document will be related to the work of specific staff specialties; for example, separate operational sections for nursing and portering staff could be included in an overall document but separately issued for these disciplines.

Site plans

7. A small (A3/A4) site plan should be drawn up, showing the location of VIE, plantrooms, cylinder stores, main buildings, roads etc. No pipework details need be shown, as the plan is only presented to facilitate actions in the event of an emergency. Relevant pipework drawings can be referenced on this plan but need not be included in the policy, as this will lead to a very bulky document.

Other guidance

8. There is little point in the MGPS policy reiterating guidance issued by other departments or staff (for example fire practice). However, where appropriate, this documentation should be referenced accordingly and any relevant contacts listed.
9. Many policies fail to achieve operational usefulness by a simple failure to update basic information such as names and telephone numbers.
10. It is important to keep any lists of personnel/ telephone numbers etc up to date and, preferably, together in one easily accessible section of the policy (for example as a separate appendix).

Emergencies

11. This is probably the most important section of the operational policy, and it is crucial that information here is accurate, clear, concise, up to date and, above all, written with safety in mind.
12. It will help if this section is immediately accessible and identifiable, for example by colour-coding, with a reference on, or inside, the front cover of the policy.
13. This section should be compulsory reading for all staff working with the MGPS.

Description of the MGPS

14. This is usually for Estates department use. Very detailed information on the MGPS can be included in a master copy of the policy. However, in an emergency such data is often of little use, and the bulk of the document only contributes towards a reluctance to use it.
15. Detail such as equipment lists, for example terminal unit types, locations and numbers, is best kept separately in an “equipment schedule”, leaving the policy as a smaller, easily accessible publication.
16. For the main policy document, each of the major system components (that is, manifolds, compressors

etc) needs to be treated in separate sections under the following headings:

- Security
- Communications/documentation
- Emergency actions
- Routine operations
- Location
- Safety
- Personnel/responsibilities.

17. A choice therefore exists at this point: either to treat each gas system in turn, applying all of the above headings to every system, or to use each heading in turn, with all gas systems described under each heading.
18. The former method is generally easier to apply and is less confusing in the event of an emergency, especially as most emergencies involve only individual gas systems.
19. The following checklist is offered as a prompt to typical policy inclusions, and is not to be considered definitive or exhaustive:
 - key control procedures (routine and emergency);
 - actions in the event of an alarm;
 - posting of safety instructions/notices;
 - use of personal protective equipment;
 - procedures for ensuring continuity of supply;
 - manifolds/cylinder ordering/stock control/VIE filling and monitoring etc;
 - general fault reporting procedures, including cylinder defect reporting;
 - manifold room practice/procedures;
 - policy statement for use of lasers/surgical diathermy with dedicated vacuum systems;
 - permit-to-work system/variations/responsibilities etc;
 - MGPS testing procedures/responsibilities;
 - cylinder supply and control procedures;
 - COSHH-related statements (for example anaesthetics/AGS systems);
 - bacteria-filter changing procedure;
 - procedure for cleaning vacuum systems;

- references to use of other permits, for example hot work, confined spaces;
- responsibility statements for record-keeping (drawings/maintenance logs/modifications);
- references to other safety policies, for example fire;
- policy statement for users of oxygen equipment (use of approved toys, cosmetics, substances etc and the fire risk associated);
- statements detailing consultancy arrangements with the Authorised Person (MGPS) before purchase/connection of medical equipment for/to the MGPS (especially CPAP units);
- statements related to the use of contractors;
- lists of personnel and arrangements for departmental cover in the event of absence;
- statements for users giving awareness of capacity/limitations of the MGPS;
- locations of special gas connectors/emergency regulators/hoses/brazing equipment etc;
- normal and emergency procedures for the interruption of a gas supply.

Emergency actions

20. Actions in the event of MGPS emergencies should be summarised. The final number of defined emergencies will vary according to each system, but as a minimum should include:
 - major gas leaks;
 - interruption of the gas supply;
 - electricity failure;
 - low/high gas pressure;
 - pollution of the gas supply; and
 - fire.
21. The following should also be given consideration:
 - location and type of emergency supplies;
 - responsibility for maintaining and providing emergency supplies;
 - training of staff in the use of emergency equipment;
 - training of staff in equipment failure procedures;

- communication channels in the event of an emergency:
 - fire officer/brigade;
 - Estates department;
 - pharmacy;
 - portering staff;
 - administration/press officer;
 - nursing/clinical.

Appendix B – A sample operational policy

It must be emphasised that this policy is not definitive, being only one approach of the many possible.

Where appropriate, the text is broken, and explanation or prompts for further consideration are inserted *in italics*.

The policy is written in the light of changes both in content of Health Technical Memorandum 2022, the permit-to-work system and appointment of Authorising Engineers (MGPS) etc.

[Premises] NHS trust

Operational policy and procedures for the management of medical gas pipeline systems

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See **Annex 2**

Contents

[To be completed on completion of body of document.]

General policy statements

This policy addresses the provision of a piped medical gas pipeline system (MGPS) in *[name of site]*.

The MGPS provides a safe, convenient and cost-effective supply of medical gases to points where these gases can be used by clinical and nursing staff for patient care.

[Premises] management recognises its commitment to maintaining the MGPS to required standards and the training of all personnel associated with its operation.

Scope of policy

This policy is intended for use by all staff involved with MGPS in *[name of site]*. *[Further sites can be added here if within the area of responsibility of the Authorised Person (MGPS), or covered by this policy.]*

It applies throughout the *[premises]* to all fixed medical gas pipeline systems and *[list of plant and areas, for example dental, HSSD, where MGPS may be installed]*.

Compressed gas and vacuum supplies to general engineering workshops and pathology department equipment are separate from the general MGPS, and are not included in this policy, although the general principles in this document should be followed for these departments.

MGPS terminal units define the limits of Estates' *[or other organisation]* responsibility in this policy.

Equipment connected to the terminal units is not covered by this policy other than where its mode of use may affect system operation or safety.

[If medical equipment is to be included, this will have to be mentioned here.]

Medical equipment is the responsibility of the *[name of department/organisation]*.

Medical gases should not be used for non-medical purposes other than as a test gas for medical equipment.

Medical air should be used as the power source for ventilators; the routine use of oxygen as a driving gas is to be avoided.

MGPS management responsibility for *[premises]* resides with the *[usually Estates]* department.

It is *[premises]* policy that, before work on the MGPS can commence, a permit-to-work form signed by an Authorised Person (MGPS) must be completed.

Responsibilities

Chief executive [or general manager]

Ultimate management responsibility for the MGPS rests with the *[premises]'s* chief executive *[or general manager]*.

The chief executive *[. . .]* herein delegates written appointment of Authorised Persons (MGPS) to *[name]*.

The chief executive *[. . .]* herein delegates day-to-day management responsibility for the MGPS to *[name – usually Senior Authorised Person (MGPS)]*.

Authorising Engineer

The duties and responsibilities of the Authorising Engineer are:

- to recommend to the *[usually estates]* manager those persons who, through individual assessment, are suitable to be Authorised Persons (MGPS);
- to ensure that all Authorised Persons (MGPS) have satisfactorily completed an appropriate training course;
- to ensure that all Authorised Persons (MGPS) are re-assessed every three years and have attended a refresher or other training course before such re-assessment;
- to review the management systems of the MGPS, including the permit-to-work system;
- to monitor the implementation of the operational policy and procedures.

[Add additional duties if required.]

Authorised Person (MGPS)

[Number] Authorised Person(s) (MGPS) are required for *[premises]* and will be based in *[premises]*.

The Authorised Person(s) (MGPS) are listed in **Annex 3**.

The Authorised Persons (MGPS) assume effective responsibility for the day-to-day management and maintenance of the MGPS.

The duties and responsibilities of Authorised Persons (MGPS) are:

- to ensure that the MGPS is operated safely and efficiently in accordance with the statutory requirements and guidelines;
- to manage the permit-to-work system, including the issue of permits to Competent Persons (MGPS) for all servicing, repair, alteration and extension work carried out on the existing MGPS;
- to supervise the work carried out by Competent Persons (MGPS) and monitor the standard of that work (a register of Competent Persons (MGPS) must be kept);
- to ensure that the *[premises]* MGPS maintenance specification and schedule of equipment (including all plant, manifolds, pipework, valves, terminal units and alarm systems) are kept up to date;

- to liaise closely with Designated Nursing/Medical Officers, the Quality Controller (MGPS) and others who need to be informed of any interruption or testing of the MGPS;
- to provide technical advice to those responsible for the purchase of any medical equipment which will be connected to the MGPS in order to avoid insufficient capacity and inadequate flow rates;
- in accordance with the *[premises]* policy on provision of services, provide advice on the provision and/or replacement of MGPS central plant and associated systems (the *[name]* department will hold overall responsibility for the provision and maintenance of MGPS services within the *[premises]*);
- to organise such training of *[estates]* staff (and other staff if requested) and/or transfer of MGPS information as is needed for the efficient and safe operation of the MGPS.

Competent Person (MGPS)

All Competent Persons (MGPS) are craft persons, employed by *[entry here will depend on employer, that is direct labour and/or contractor. If both are employed, the term Competent Persons (MGPS) could be added to distinguish contractors' staff]. [Throughout the remainder of this document, the word "approved" will not be used, but its insertion can be inferred from the references to Competent Person (MGPS).]*

All Competent Persons (MGPS) shall be registered to BS EN ISO 9001/BS EN ISO 13458, with clearly defined registration criteria.

The duties and responsibilities of Competent Persons (MGPS) are:

- to carry out work on the MGPS in accordance with the *[premises]*'s maintenance specification;
- to carry out repair, alteration or extension work as directed by an Authorised Person (MGPS) in accordance with the permit-to-work system and Health Technical Memorandum 02-01;
- to perform engineering tests appropriate to all work carried out and inform the Authorised Person (MGPS) of all test results;
- to carry out all work in accordance with the *[premises]* health and safety policy.

Quality Controller (MGPS)

It is the responsibility of the *[name]* to appoint, in writing, on the recommendation of the chief pharmacist, a quality control pharmacist with MGPS responsibilities.

The Authorised Person (MGPS) will be responsible for liaising with the Quality Controller (MGPS) and organising attendance as required.

The duties and responsibilities of the Quality Controller (MGPS) are:

- to assume responsibility for the quality control of the medical gases at the terminal units (that is, the wall or pendant medical gas outlets);
- to liaise with the Authorised Person (MGPS) in carrying out specific quality and identity tests on the MGPS in accordance with the permit-to-work system and relevant Pharmacopoeia standards;
- to organise MGPS training of pharmacy staff who may deputise for the Quality Controller (MGPS).

He/she should have received training on the verification and validation of MGPS and be familiar with the requirements of this MGPS operational policy.

The pharmacy department at the *[premises]* will:

[The responsibilities of the pharmacy department may be inserted here (see typical list below). However, much will depend on whether a pharmacy department exists on the premises or whether pharmacy control is from another site.

There will also be different insertions if the Quality Controller (MGPS) function is provided from another site within the trust and/or the Quality Controller (MGPS) is from an independent organisation.

In the latter instance, the exact terms of reference for appointment and call-out etc should be defined.]

- receive delivery notes for compressed gas cylinders, check against invoices received and pass invoices for payment;
- order and supply (via *[name of department, for example portering]*) cylinders of medical gases and special gas mixtures for the following areas:

[Define wards and departments.]

[Define manifolds, as others may have responsibility for cylinder supply to specific units.]

- maintain a record of cylinder rental charges and pass rental invoices for payment;
- ensure that cylinder gases comply with Ph. Eur. requirements;
- ensure that other gases and gas mixtures comply with manufacturers' product licences.

Designated Medical/Nursing Officer (DMO/DNO)

[A major decision will be required here. Will the responsibility for granting permission for all levels of hazard of work lie solely with the nursing staff or a combination of medical and nursing staff, that is, DMO and DNO?

If the former applies, a statement such as the following should be included:

"It is the policy of the [premises] that all MGPS work in wards and departments carried out under the MGPS permit-to-work system will be controlled by the nursing staff. The term DMO (Designated Medical Officer) will not be used."

If both DMO and DNO positions are considered necessary, duties and responsibilities of both should be defined below.]

The duties and responsibilities of the Designated Medical/Nursing Officer are:

[This section should contain information on:

- *who the defined person is and a statement of their responsibility to liaise with the Authorised Person (MGPS);*
- *their scope of responsibility for giving permission to interrupt supplies;*
- *any requirement to employ a nurse manager/senior medical officer for high hazard work or work involving more than one department;*
- *restrictions on working hours and arrangement for out-of-hours cover;*
- *responsibilities during emergency situations;*
- *training arrangements.]*

Designated Porter (MGPS)

A Designated Porter (MGPS) is a *[usually a porter but may be different in the private sector]* with particular responsibilities for medical gases. He/she will have undergone specialist training in the identification and safe handling and storage of medical gas cylinders, including relevant manual handling training.

Designated Porters (MGPS) in the *[premises]* will undertake the following duties:

- assist with the delivery of gas cylinders by *[gas supplier]*;
- deliver full gas cylinders from the *[usually cylinder stores]* (as appropriate) to *[areas]* and return empty cylinders to these stores;
- transfer gas delivery notes from the delivery driver to the *[usually pharmacy]*;
- attach to and remove from cylinders, medical equipment regulators (or regulator/flowmeter combinations) and manifold tail-pipes;
- identify, and remove from service, faulty (eg leaking) cylinders and subsequently notify *[usually pharmacy]* of the location of such cylinders;

- perform a weekly check on cylinder stocks and report any deficiencies to *[usually pharmacy]*;
- ensure that all cylinder contents are used within the three-year fill/refill timescale specified by the gas supplier.

The Designated Porter (MGPS) must work safely at all times, using the appropriate personal protective and manual handling equipment, damage to which must be reported immediately to *[name]*.

Medical gas committee

A medical gas committee shall consist of the Senior Authorised Person (MGPS), the *[premises]* matron (or a nominated *Designated Nursing/Medical Officer*), the portering manager, the Quality Controller (MGPS) *[etc]*.

Other signatories to this document shall also be invited to join the group when appropriate.

MGPS operational policy review

The MGPS operational policy should be reviewed *[frequency]*; the Authorised Person (MGPS) *[or other nominated chair]* shall convene the review meeting and be responsible for writing and distributing the minutes of the meeting. The committee shall report to the chief executive/general manager.

MGPS record drawings and documentation

The Authorised Person (MGPS) will maintain copies of the following *[delete/add as applicable]*:

- up-to-date and accurate as-fitted record drawings (including valve/key numbers/TU identification) for all MGPS;
- any necessary MGPS insurance/statutory documentation;
- MGPS safety valve replacement schedule (on a five-yearly basis);
- new and completed permit-to-work books for work on the systems;
- plant history/maintenance records;
- manufacturer's technical data sheets/manuals for all MGPS components;
- Health Technical Memorandum 02, all latest editions of any associated supplements and NHS Model Engineering Specifications;
- MGPS contractors' service contracts and ISO 9001 (or equivalent) certificates, staff training records, equipment calibration certificates (copies);
- a list of all personnel associated with the MGPS, especially the permit-to-work system;
- emergency and other useful telephone numbers;
- MGPS staff training records;
- calibration certificates of *[premises]*-held test equipment;
- the MGPS operational policy.

Pharmacy will maintain copies of the following *[delete/add as applicable]*:

- delivery notes for medical gas cylinders;
- sales invoices for medical gas cylinders;
- delivery summary form (tracks cylinder stock information);
- cylinder rental invoices;
- cylinder rental reconciliation form (monitors trends in cylinder use over six months);
- delivery notes for special gas and industrial gas cylinders;

- sales invoices for special gas and industrial gas cylinders;
- rental invoices for special gas and industrial gas cylinders;
- calibration records of QC test equipment and records of all QC tests performed.

Training

It is essential for the safety of patients that no person should operate, or work on, any part of an MGPS unless adequately trained or supervised.

MGPS training at the *[premises]* for all *[usually estates]* staff is administered by *[name/department]*.

A record of those trained is kept in the *[department]*.

It is the duty of departmental managers to ensure that all staff working with the MGPS are appropriately trained.

The Authorised Person (MGPS) may request training records of contractors' staff.

Training on MGPS will be provided as follows:

[Insert a table showing various grades of staff, who is to provide training, and how often the training is provided. This will include refresher training.]

The MGPS structure

[This section should be devoted to a short description of the plant and other components of the MGPS. It is usual to include cylinder management within this section.]

Each item will be presented in terms of a description of the plant/component/system, its location, emergency reserve provision, access arrangements (including key control) and safety and signage requirements.

As an example, a compressed medical air system is described, and this is presented in two different forms:

- with contact details included in this section;*
- with contact details referenced to an appendix.*

(a) has the obvious advantage of all information on air plant being presented on one page;

(b) has the advantage that updates to a single appendix are easier than having to update several sections of the policy.]

Example 1: Medical compressed-air plant – presentation type (a)

Summary

A *[make]* duplex medical air compressor/dryer unit supplies medical compressed air to the *[premises]*.

It is housed in the *[location]* and provides both medical and surgical air.

A manual cylinder manifold (*[make, size and number of cylinders]*), set to come on line automatically in the event of plant failure, supports this plant; it is located in the same room.

Security – access

The compressor unit and its emergency supply manifold are located in locked rooms. Competent Persons (MGPS) should be allowed, on proof of identify, to gain access by signing out the relevant keys from *[usually Estates]*.

Security – key-holders:

<i>[Usually Estates]</i>	Contact number xxxx
Portering	Contact number xxxx
EBME	Contact number xxxx

Emergency contact

[Usually Estates]	Contact number xxxx
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Signage

Appropriate identification and safety warnings should be displayed in accordance with current requirements.

A notice should state the location of the keys and be fixed to the plantroom door.

Example 2: Medical compressed-air plant – presentation type (b)

Summary

A [make] duplex medical air compressor/dryer unit supplies medical compressed air to the [premises].

It is housed in the [location] and provides both medical and surgical air.

A manual cylinder manifold ([make, size and number of cylinders]), set to come on line automatically in the event of plant failure, supports this plant; it is located in the same room.

Security – access

The compressor unit and its emergency supply manifold are located in locked rooms. Competent Persons (MGPS) should be allowed, on proof of identity, to gain access by signing out the relevant keys from [usually Estates].

Security – key-holders

Keys for these rooms are available from [location] or by contacting [name]. See [Annex 3](#) for list of contacts.

Emergency contact

In an emergency, see Annex 3 for contact details.

Signage

Appropriate identification and safety warnings should be displayed in accordance with current requirements.

A notice should state the location of the keys and be fixed to the plantroom door.

Other plant/systems

[Other plant will be described as in (a) or (b) above and will include separate descriptions for each manifold, compressor etc.

AGSS often have multiple installations, and it may be more convenient to show these in a simple table format detailing pump type, simplex/duplex format and area served.

Although alarm systems will be described here, actual responses to alarm indications are better covered in other sections of the policy (see below).

If the Authorised Person (MGPS) has any responsibility for dental/pathology systems, these should have been included in the “duties and responsibilities” section above. Details of plant within that area of responsibility can be detailed here.]

Cylinder storage

[Each storage area (main, ready-to-use etc) must be addressed separately in terms of location, access and emergency use.

General information common to all store types, for example signage and storage conditions, can be added to this section.

This information can be copied directly from [Chapter 8](#) (“Cylinder management”) in Part B of Health Technical Memorandum 02-01.]

Area valve service units (AVSUs)

Summary

Locked boxes containing isolating valves in enclosures with breakable glass fronts (area valve service units (AVSUs)) are provided at the entrance to wards and departments.

These valves provide facilities for both routine and emergency isolation of gas supplies.

These valve boxes contain an emergency inlet port, which is gas-specific. This may be used to supply gas to a ward when the main supply fails or is shut down for essential engineering work.

[Non-NIST AVSUs should also be referenced here, but the essential message is that, regardless of type, emergency isolation can be effected by breaking the cover and closing the valve.]

General rules and conditions for control of LVAs

Pipeline valves (called lockable line valve assemblies (LVAs)) in ducts, risers, ceiling spaces etc shall be locked in the normal operating position.

Pipeline valves will normally be left unlocked if they are sited in a locked plantroom. *[Usually Estates]* will hold keys for these valves.

Access

Under normal events, only the Authorised Persons (MGPS) using the appropriate key from the *[usually Estates']* medical gases key cabinet should access AVSUs and any other locked LVAs under control of a permit-to-work.

The key cabinet contains a list identifying all AVSUs and locked LVAs, with corresponding key numbers.

Key-holders

Key-holders are listed in [Annex 3](#).

In the event of an emergency, access to the valve boxes and AVSUs may be gained by smashing the breakable glass fronts.

A member of the nursing staff will perform this action after steps have been taken to ensure that no patient is compromised by isolation of the gas supply.

[At this point, a diagram/photograph of an AVSU can be added, illustrating the various components, although this can be either left for later in the policy ("emergency actions") or even printed as a laminated hand-out for posting near AVSUs in wards etc.]

Routine procedures

The MGPS permit-to-work system

The aim of the MGPS permit-to-work system is to safeguard the integrity of the medical gas system and, therefore, the safety of the patients.

It is the policy of *[trust/premises/organisation]* that – with the knowledge and permission of the Authorised Person (MGPS) – a permit must be raised before any work (except changing of manifold cylinders *[add VIE refilling, QC testing of medical/surgical air etc here if relevant]* or emergency isolation by a member of the nursing staff) can be undertaken on any part of the *[premises]* medical gas system.

Granting of a permit-to-work and the way in which the work is carried out must follow the directions of Health Technical Memorandum 02-01 unless otherwise defined in this policy.

Responsibilities for signing a permit-to-work lie with the Designated/Medical Nursing Officers in each department.

Officers should ensure that colleagues are advised of the interruption to the gas supply and its estimated duration.

Officers should also ensure (via *[usually Estates]*) that all affected terminal units are appropriately labelled.

Planned interruption

A planned interruption will be needed for repair, extension or modification to the existing MGPS. An Authorised Person (MGPS) shall supervise any planned interruption in strict accordance with the permit-to-work system in Health Technical Memorandum 02-01. The Quality Controller (MGPS) shall be involved in any planned interruption from the initial planning stage.

The Authorised Person (MGPS) shall assess the hazard level of the work to be carried out in accordance with the definitions that are given in the following sections for high and low hazard work. *[Medium hazard is no longer used as a classification.]*

High hazard work

Any work on the MGPS, such as cutting or brazing, that will introduce hazards of cross-connection and pollution will be classified as high hazard.

Cross-connection, performance, identity and quality tests shall be required before the MGPS is taken back into use.

High hazard work might require, at the least, a planned interruption to a single ward or department or, at worst, a major shut-down of a system to a whole *[premises]* site.

In such events, an Authorised Person (MGPS) must ensure that key personnel for each ward or department are informed; if necessary, he/she could hold a site meeting.

The Quality Controller (MGPS) should be included in any discussions that may lead to an interruption of the MGPS.

Two weeks before the planned interruption, the Authorised Person (MGPS) shall liaise in person with the *Designated Nursing/Medical Officer(s)* of the ward(s) or department(s) concerned.

At the same time, the Authorised Person (MGPS) will complete part 1 of the permit-to-work form.

The *Designated Nursing/Medical Officer(s)* of the ward(s) or department(s) involved will be made aware that their signatures will be required on the date on which the work is due to take place.

The requirement for portable cylinders or vacuum units will be determined and confirmed, with details of the interruption, by a memorandum from *[usually Estates]* to the *Designated Nursing/Medical Officer(s)*.

A copy of this memorandum will be sent to the ward(s) or department(s) concerned. A further memorandum, requesting the services of a Quality Controller (MGPS) and detailing the requirements for portable cylinders, shall be sent to the pharmacy department *[or other QC organisation]*.

It is the responsibility of the Authorised Person (MGPS) to arrange, through the portering and pharmacy departments or an appropriate hire firm if necessary *[delete as applicable]*, for portable cylinders and regulators (stocks of regulators are held by *[department]*).

Any additional portable vacuum units to be supplied are the responsibilities of the wards/departments concerned.

The Authorised Person (MGPS) will provide all details of the work to be carried out in part 1 of the permit-to-work form, including any other permits (for example for “hot works” or for entry into confined spaces).

Work shall only commence when the senior duty nurse(s)/medical officers for the ward(s) or department(s) is/are satisfied that no patients will be put at risk by the shut-down of the MGPS and has/have signed part 1 of the permit-to-work form.

The Authorised Person (MGPS) will then supervise isolation of the AVSU(s) by the Competent Person (MGPS) after:

- a. confirming isolation details by consultation with the Competent Person (MGPS); and
- b. examining the sketch on the fourth sheet of the permit and any additional drawings (if available).

Once the system(s) has/have been isolated and depressurised, the Competent Person (MGPS) will sign:

- a. part 2 and

b. (together with the Authorised Person (MGPS)) the fourth sheet of the permit-to-work form, and then commence work.

The Competent Person (MGPS) will sign part 3 of the permit to certify that work has been completed and contact the Authorised Person (MGPS) so that the installation may be examined and tested.

Depending on the extent of high hazard work, the Authorised Person (MGPS) will determine and carry out, with the assistance of the Competent Person (MGPS), the necessary tests and examination of the system(s) in accordance with Chapter 15 “Validation and verification” in Part A of Health Technical Memorandum 02-01.

When these tests have been completed satisfactorily, the Authorised Person (MGPS) will initial the relevant spaces and sign part 3 of the permit.

The Quality Controller (MGPS), with the assistance of the Authorised Person (MGPS), will carry out identity and quality tests on the system(s) in accordance with Chapter 15 “Validation and verification” in Part A of Health Technical Memorandum 02-01.

When these tests have been completed with satisfactory results, both will sign part 4 of the permit. Unsatisfactory results may lead to cancellation of the permit.

The Quality Controller (MGPS) will receive the pink copy of the permit-to-work form from the Authorised Person (MGPS).

Note: It should be the normal practice of [*usually Estates*] to retain the white copy, the original (yellow) copy and the fourth sheet in the permit-to-work book. Photocopies (signed and dated by the Authorised Person (MGPS) and the Competent Person (MGPS)) of the white copy may be issued to the Competent Person (MGPS) on request.

The *Designated Nursing/Medical Officer(s)* will accept the system(s) back into service by signing part 5 of the permit and will undertake to notify his/her colleagues that the system is fit for use.

Low hazard work

Any work on the MGPS which will not introduce any hazard of cross-connection or pollution will be classified as low hazard work.

A performance test will be required before the MGPS is taken back into use.

If there is any doubt as to the hazard level classification of a particular permit-to-work, advice should be sought from the Senior Authorised Person (MGPS).

Low hazard work on terminal units is normally the result of a leak on an individual terminal unit due to a faulty valve or seal, but may also include work on plant which does not interrupt gas supplies.

This type of work is usually carried out at short notice because of the need for minimum disruption to patient care. The Authorised Person (MGPS) may have to arrange a portable cylinder or vacuum unit so that the terminal unit can be taken out of service.

The Authorised Person (MGPS) will fill out the relevant section of part 1 and the fourth sheet of the permit-to-work form. The Authorised Person (MGPS) will liaise with, and fully brief, the senior duty nurse/medical officer of the ward/department, who will then sign part 1, if required.

The Authorised Person (MGPS) will provide all details of the work to be carried out in part 1 of the permit-to-work form. These should relate directly to the sketch on the fourth sheet of the permit.

When satisfied with the extent of the work, the Competent Person (MGPS) will sign:

- a. part 2 and
- b. (together with the Authorised Person (MGPS)) the fourth sheet of the permit-to-work form, and then commence work.

The Competent Person (MGPS) will sign part 3 of the permit to certify that the work has been completed, and contact the Authorised Person (MGPS) for the installation to be examined and tested.

The Competent Person (MGPS), with the assistance of the Authorised Person (MGPS), if necessary, will carry out flow, pressure drop, mechanical function and gas-specificity tests on the serviced terminal unit(s).

Other equipment function tests, for example on plant, will be made to the satisfaction of the Authorised Person (MGPS).

The Authorised Person (MGPS) and Competent Person (MGPS) will initial the relevant spaces and sign part 3 of the permit.

When satisfied with the test results, the Authorised Person (MGPS) will sign part 4 of the permit, or indicate that further work is necessary.

The senior duty nurse/medical officer of the ward or department will accept the MGPS back into service by signing part 5 of the permit, and will undertake to notify his/her colleagues that the system is fit for use or requires further work.

Actions in the event of a medical gas alarm

[One proven method of approaching this topic is to actually include a simple sketch of the relevant alarm display, adding text to describe the actions appropriate to each indication.

This may become cumbersome if a wide variety of panels are installed, but this is not generally the case.

Again, laminated sketches, similar to those in the policy (and shown in Example 1 below) can be posted adjacent to the relevant panel(s).]

The diagrams below show the actions that should be taken at each level of alarm.

On detection of a local alarm indication, for example in a ward area, the senior duty nurse *[or other nominated person]* should contact the switchboard to confirm that a fault has been signalled and that *[usually Estates]* has been informed.

In the event of an alarm condition on the central alarm panel, it is the responsibility of the duty telephonist *[or other nominated person]* to inform the appropriate staff as shown in **Example 1**.

Notes

Disabling the alarm system, other than when due authorisation has been obtained from an Authorised Person (MGPS), is absolutely forbidden, as this may compromise patient safety.

There should always be a “normal” light. If there is no “normal” light, then there is a fault of some kind, possibly just with the alarm panel.

However, *[usually Estates]* should investigate this fault.

Alarms should be tested weekly by a Competent Person (MGPS) *[or other nominated person]*.

Operation of the test button will confirm operation of all audible/visual indicators.

Nursing/medical staff should be advised of this test.

Example 1: Medical air/surgical air

Alarm indication	Action (telephonist to inform)
Normal	No action to be taken
Plant fault	NWH – Estates ONWH – Estates (on-call rota)
Plant emergency	NWH – Estates ONWH – Estates (on-call rota)
Reserve low	NWH – Porters ONWH – Porters
Pressure fault	NWH – Estates ONWH – Estates (on-call rota)
Panel indication (all alarm panels)	
Alarm indication	Action (telephonist to inform)
Power on	No action to be taken
System fault	NWH – Estates ONWH – Estates (on-call rota)
Abbreviations: NWH = Normal working hours ONWH = Outside normal working hours	

It is the responsibility of the Authorised Person (MGPS) to ensure that a procedure for each alarm indication is displayed next to the respective central alarm panel.

[Note: diagrams showing local alarm conditions can also be laminated and posted adjacent to the panels. They should also be illustrated in the policy.]

Cylinder management

[This section is copied (amended where appropriate) directly from Chapter 8 in Part B of Health Technical Memorandum 02-01.

It should cover preparation of cylinders for use, cylinder storage, handling and transport, cylinder changing on manifolds and medical equipment, special instructions for manual emergency reserve manifolds (for example leaving one (cylinder) valve open and one closed), delivery of gases to wards, stores etc, delivery of liquid oxygen.

Reference should be made to training in manual handling and inclusion of a statement that only Designated Porters (MGPS) are allowed to work with cylinders.

Restrictions on the work of the Designated Porters (MGPS), if any, should be inserted here. An example would be that only estates staff are allowed to change oxygen cylinders within a cryogenic liquid storage system compound.]

Shut-down of the MGPS for maintenance, extension etc

Pre-planned work on the MGPS requiring isolation of a plant, or part of the system, will be covered by the MGPS permit-to-work system.

No isolation should take place without full liaison between the Authorised Person (MGPS) and all other disciplines.

All necessary emergency/additional gas supplies should be in place before the work starts. This may involve the provision of portable emergency supply systems and/or additional provision of cylinder regulators from *[usually Estates]*.

Attempts should be made to reduce gas consumption during the work.

Generator operation on mains failure

[This is included here as a “routine procedure”, which (under normal circumstances) it should be. However, it is not difficult to see how the situation could quickly become more serious. Hence, although the “emergency procedures” section will cover electrical mains failure, there is little wrong with including some warnings and appropriate actions in this section to cover the event of generator failure.]

During changeover from electrical mains to emergency generator supplies, there is always a possibility that spurious MGPS alarms, or changes in plant indications, may be generated.

These alarms must be investigated immediately, as they could represent real, rather than false, conditions. The status of equipment such as compressors should also be checked to ensure they are operating as selected: on/on stand-by/on duty mode/off.

Additionally, it must be remembered that **failure of generator and mains supplies simultaneously will result in failure of the central medical vacuum system.**

It is important that clinical/nursing staff are aware of this risk to the vacuum system and any patients using it.

All relevant staff must undertake training in the use of emergency vacuum equipment.

In areas where vacuum supply is considered critical, locally-generated vacuum will have to be provided. However, with a failed electricity supply, this will not be possible using the normal electrically-driven portable suction units.

For critical care use, ejector-driven suction units can be used. These are usually powered from the main oxygen supply via a terminal unit or from a separate compressed gas cylinder (oxygen or medical air).

An alternative would be a battery-driven suction unit, but it is important that, with this type of unit, the battery is maintained in a fully-charged condition.

To locate portable vacuum units, call *[department]*.

Failure of both mains and electricity supplies will also mean that the medical air compressors will not function.

Emergency supplies of medical air will be provided from the automatic cylinder manifold unit, but clinical staff must attempt to conserve air wherever possible so that essential supplies to patient ventilators are maintained.

Estates *[or other organisation]* staff must ensure that all plant equipment and alarms have reset to full operating conditions on restoration of power.

Use of oxygen at high concentrations

Where oxygen is in use in large quantities and/or in higher than normal concentrations, for example in oxygen tents and incubators, warning notices indicating “high concentration oxygen in use – danger of fire” should be posted at the treatment site.

The *[premises]* fire officer should be consulted on the use of toys in oxygen tents, and a notice worded “only toys, cosmetics etc approved by the fire officer are allowed in this area” must be posted at the entrance to the treatment area.

It is the responsibility of all staff in such areas to be vigilant in all aspects of the treatment, and appropriate safety training must be given in the use of oxygen under these conditions.

[The use of small adhesive warning triangles, posted adjacent to oxygen terminals, is becoming commonplace. If such notices are to be used, mention should be made of this in the policy. Additionally, appropriate staff training should be given in the identification and significance of these warnings.]

Emergency procedures

Use of emergency reserve manifolds

[The sample text below will probably require considerable amendment to suit particular circumstances. The title also refers to emergency reserve manifolds such as those attached to plant.

Additional manifolds may be supporting the system (for example a local manifold sited nearby) and used to supply oxygen to a critical care area in the event of a main system failure. These manifolds are referred to as emergency supply manifolds in order to distinguish them from those attached to plant and other manifolds.

It will be necessary to describe the location and emergency operating procedures for all the types of manifold on the premises.]

General statement

Emergency supply manifolds are attached to all medical gas systems.

Oxygen system

In the event of failure of the primary (CLS) oxygen supply, the secondary (cylinder manifold) supply will automatically provide the *[premises]* with gas.

The manifold supply will change banks automatically but will require cylinder replacement as a bank empties.

Important: Cylinder manifolds have limited capacity in relation to the normal *[premises]* demand supplied from a CLS, so additional manpower may be required in an emergency situation of this kind, both to change the cylinders on the manifold and to bring the replacement cylinders to the manifold.

Measures to reduce gas consumption may also need to be taken.

It is the duty of *[usually portering]* to ensure that sufficient J-size cylinders are available to maintain the gas supply and that there is an emergency procedure in place for handling these cylinders.

Medical and surgical compressed air

The automatic manifold supporting the medical air plant will come on line automatically and will change banks automatically.

Cylinder replacement will be the responsibility of *[usually portering]*. Care should be taken to prevent transfer of oil/grease from the compressor plant to the manifold cylinder connections.

Nitrous oxide and Entonox

The nitrous oxide and Entonox automatic manifold systems are fitted with manually-operated emergency supply manifolds.

These supply gas in the event of failure of, or loss of gas from, the main manifold.

The ESM will come on line automatically; it will not be necessary to open the ESM main isolating valve to ensure that gas supply is maintained.

When in use, it will not change from left to right cylinder banks automatically.

[Usually Estates] and *[usually portering]* staff should be fully trained in the operation of the ESM.

Detailed instructions identifying which valves to turn and in which order shall be posted adjacent to each ESM.

Due to the limited capacity of the ESM, it is essential that the pressure in the cylinders be monitored continuously while it is in use.

Manual changeover from an almost empty to a full cylinder will be required.

A full one must then replace the empty cylinder.

It is the duty of *[usually portering]* to ensure that sufficient cylinders are available to maintain the gas supply.

The medical vacuum system has no emergency reserve manifold system. Failure of the plant for any reason will result in total failure of the vacuum service.

[The following emergencies are offered as samples only. Local circumstances will dictate the amount of alteration required.]

Emergency cylinder ordering procedure

[This tends to be very site-specific. Hence a sample is included here without further comment.]

Note: The pharmacy department will perform routine cylinder ordering based on required stock levels and weekly use. Porterage will check stocks weekly and report any deficiencies to pharmacy.

For emergency ordering, the following procedure should be followed:

- Pharmacy will telephone the emergency number of the medical gas supplier (see Annex 3).
- Pharmacy will tell the medical gas supplier that “new issues” are needed, if no empties are to be returned.
- Upon delivery by the medical gas supplier, the duty porter should check the delivery against the request and sign the driver’s delivery note.
- The note should then be passed to pharmacy.

Failure of mains electricity supply

[It will be necessary to describe the consequences of failure of both mains and essential supplies in this section.]

In the event of an electricity failure, medical gas supplies should be maintained by the emergency generator system (the “essential” supply).

The surgical compressed-air plant, vacuum plant, oxygen system, all manifolds and medical gas alarm systems are connected to the “essential” electricity supply and will continue to provide and monitor gas supplies as normal.

In the event of failure of both mains and generator supplies:

- the oxygen system will continue to supply gas from its secondary supply manifold system;
- the vacuum plant will not operate, and central vacuum service will be lost;
- “normal” portable vacuum units can be used only if local electricity supplies are available. Ejector- or battery-driven units will have to be used where vacuum provision is essential for critical care;
- the air compressor will fail, but air will be supplied from the air ESM;
- nitrous oxide and Entonox manifolds will continue to supply gas;
- alarm panels will display a “system failure” red warning light and give an audible alarm.

If the electricity supply to an alarm panel only is interrupted, the panel will display a “system failure” red warning light and emit an audible alarm; gas supplies will not be affected.

In any of these events:

- the Authorised Person (MGPS) will be informed of the situation via the nursing staff/telephonist;
- portering and estates will arrange for staff to monitor manifold gas consumption, replacing empty cylinders as necessary until the electricity supply is restored;
- the Authorised Person (MGPS) will arrange emergency cylinder/regulator supplies as necessary;
- the Authorised Person (MGPS) will monitor the situation and confirm resetting of compressor and vacuum plant and system alarms following restoration of supply.

A serious leak of medical gases

In these events:

- the duty porter and the Authorised Person (MGPS) will be contacted by the telephonist/duty nurse;
- details of the leak should be confirmed: that is, the floor level, department, room number, the gas or gases involved and whether patient ventilators are in use;
- outside normal working hours, the on-call engineer will notify the Authorised Person (MGPS);
- it is the responsibility of the duty nurse to carry out isolation of medical gases to the area after ascertaining that no patients will be put at risk in any area(s) affected by the isolation;
- the duty nurse will issue appropriate instructions to make the situation safe, such as to open windows in the affected area and close doors, in accordance with the *[premises]* fire policy;
- the duty porter will remain on stand-by to provide extra gas cylinders as required;
- the Authorised Person (MGPS) will arrange for repairs to the system(s) affected to be carried out under the permit-to-work system.

[Local arrangements may be in place to contact the risk manager or press officer in such an occurrence. This should be documented in the policy.]

Total or partial failure of a medical gas supply

In these events:

- the person discovering the failure will inform the telephonist and duty nurse immediately;
- the telephonist will inform the duty senior manager, the duty porter and the duty Authorised Person (MGPS) of the leak;
- details of the failure should be confirmed: that is, floor level, department, room number(s), the gas or gases involved and whether patient ventilators are in use;
- as a precautionary measure, the telephonist will also notify critical care areas that a failure has occurred on part of the system so that they are prepared in the event of the fault extending to their departments;
- it is the responsibility of the duty nurse to check which patients may have been put at risk by the failure and, if necessary, to arrange immediate emergency medical action;
- depending on the reason for the failure and its possible duration, the Authorised Person (MGPS) will decide the most appropriate method of long-term emergency gas provision. This may involve establishing locally-regulated cylinder supplies at ward/department entrances;
- nursing and medical staff should attempt to reduce gas consumption to a minimum during the emergency;
- portering staff will be required to monitor/replenish cylinders at any emergency stations and at plantroom emergency supply manifolds;
- pharmacy will arrange emergency cylinder deliveries as necessary;
- the Authorised Person (MGPS) will liaise with the Competent Person (MGPS) to complete emergency repairs needed to reinstate the gas supply, using the permit-to-work system;
- when the supply is fully restored, the Authorised Person (MGPS) will complete a critical incident form and produce a full report, which will be given to the *[usually chief executive/general manager]* within 24 hours of the incident.

In situations where it is envisaged that there will be long-term loss of oxygen or medical air service, the duty senior manager will liaise with clinical colleagues, including the senior nurse manager, the medical director and the Authorised Person (MGPS) on the need for transfer of critically ill patients to *[premises]*, as department closure may be warranted in extreme events.

Contamination of a medical gas supply

It is not unusual for a smell to be noticed when using “plastic” equipment hoses to deliver gas to a patient. This smell usually disappears rapidly after first use of the hose, and will generally be familiar to operatives.

However, if either operatives or patients complain of any unusual or strong smells from equipment, the situation must be treated seriously and immediate action taken to ascertain the cause.

Where it is obvious that the smell is coming from the pipeline rather than a piece of connected equipment, **the gas supply must not be used.**

In such an event, the fault should be treated as a complete gas failure to that area and the actions described above taken **immediately.**

It is very important that, if such an incident occurs, the telephonist advises **all** departments of the problem, especially critical care areas.

Contamination of the medical vacuum system will usually be detected during routine maintenance inspection and evidenced by the presence of liquid in the on-line bacteria-filter drain flask. The infection control nurse should be informed immediately and should advise on any additional precautions to effect filter change safely.

Portable suction units may be used in areas where there is a possibility of the vacuum system being contaminated. (The need for portable suction units should be discussed with the infection control officer.)

It is the responsibility of the Competent Person (MGPS) to change the filter in accordance with the procedure described in Health Technical Memorandum 02-01 and any additional advice from the infection control officer.

If the contamination is due to system misuse, the Authorised Person (MGPS) must complete an incident report form. The form is to be sent to the *[risk manager]* so that the appropriate nurse manager can be informed and remedial action taken.

Decontamination of pipework (if necessary) should be carried out in accordance with the procedure described in Health Technical Memorandum 02-01 before filters are changed.

Failure of an AGSS

Failure of an AGSS results in spillage of gaseous/vaporised anaesthetic agents into the area of use of the system.

In theatres, it is likely that staff exposure to the spilled gases will exceed the COSHH recommendations for exposure when working in the area for extended periods, even though ventilation rates are high.

A local alarm “system fail” warning and failure of the air receiver flow indicator will indicate failure of the system. Both should be inspected by operating department staff on a regular basis.

The Authorised Person (MGPS) and the theatre manager will be informed of the failure by *[usually the theatre technician/ODP]*, and all attempts should be made to reduce staff exposure, if operations continue with a failed system.

When repairs have been completed (under a permit-to-work signed by the theatre nurse manager, or their nominated deputy), theatre staff should be made aware (by the person signing off the permit-to-work) that the system is back in use.

Over- or under-pressurisation of one or more gas systems

Local alarms are designed to indicate when system pressure(s) is/are outside the normal operating range.

Excessively high or low pressures may cause medical equipment to malfunction.

The duty nurse should report all instances of local alarm operation to the telephonist.

Emergency isolation of a gas supply

[This procedure and the value of posting instructions have been referred to earlier in this section. Mention should be made of the associated nursing/medical staff training in emergency isolation actions.]

Fire

Procedures in accordance with the *[premises]* fire policy should be followed in the event of a fire involving, or likely to involve, the MGPS.

During a fire, the senior brigade officer will assume full control of the area(s) affected.

Under no circumstances should medical gas supplies be isolated until the Designated Nursing Officer has confirmed that all patients likely to be affected have been evacuated and/or have alternative gas provision.

Annex 1

Policy signatories

This policy has been prepared and will be implemented and monitored by:

Name: Signature: Date:

This policy will be monitored biannually. Date of next review *xx/xx/xx*.

Training needs associated with the policy will be coordinated by *[name]*.

The Senior Authorised Person (MGPS) for medical gas systems within the *[premises]* is *[name]*.

This policy is accepted by:

Chief Executive

Name: Signature: Date:

Senior Authorised Person (MGPS)

Name: Signature: Date:

Senior/QC Pharmacist

Name: Signature: Date:

Senior Designated Nursing/Medical Officer

Name: Signature: Date:

Clinical Risk Manager

Name: Signature: Date:

Security and Portering Manager

Name: Signature: Date:

Infection Control Officer

Name: Signature: Date:

Fire/Safety Officer

Name: Signature: Date:

Assistance with the interpretation of this policy, or additional copies, can be obtained by contacting *[name]*.

Annex 2

Policy circulation list

[illegible]

Annex 3 – Contacts

Authorised Persons (MGPS)

Name	Contact number

Competent Persons (MGPS)

Name	Contact number

Designated Medical/Nursing Officers (MGPS)

Name	Title	Contact number

Other important telephone numbers

Name	Contact number	Out-of-hours contact number
Portering		
Pharmacy		
Gas supplier		
Risk manager (emergency)		

Keyholders

Name	Contact number	Out-of-hours contact number

Annex 4 – Contractors

[A list, giving all relevant contact details, should be included for all contractors working on the MGPS. Of particular importance are the emergency contact details of MGPS maintenance contractors and gas suppliers.]

In the case of gas suppliers, it would be useful to note the cylinder and liquid supplies account details to facilitate emergency deliveries.

Contact names and positions should be included wherever possible.

*Additional statements pertaining to training and accreditation of contractors can also be included here. This is best copied from **Chapter 10** in Part B of Health Technical Memorandum 02-01.*

*Responsibility for providing as-fitted drawings is also described in **Chapter 10** and this could also be added here.]*

Annex 5 – Statutory requirements relevant to medical gas pipeline systems

[This is not an exhaustive list.]

- Health and Safety at Work etc Act 1974
- Management of Health and Safety at Work Regulations 1999
- Workplace (Health, Safety and Welfare) Regulations 1992
- Provision and Use of Work Equipment Regulations 1998
- Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995
- Control of Substances Hazardous to Health (COSHH) Regulations 2002
- Pressure Equipment Regulations 1999
- Pressure Systems Safety Regulations 2000
- Highly Flammable Liquids and Liquefied Petroleum Gases Regulations 1972
- Medicines Act 1968
- Manual Handling Operations Regulations 1992 (as amended 2002)
- Personal Protective Equipment at Work Regulations 1992
- Electromagnetic Compatibility Regulations 2005
- Electricity at Work Regulations 1989
- Other guidance applicable to medical gas pipeline systems
- Health Technical Memorandum 02-01 – ‘Medical gas pipeline systems’:
 - Part A: Design, installation, validation and verification
 - Part B: Operational management
 - Supplement No 1 – ‘Dental compressed air and vacuum systems’
 - Supplement No 2 – ‘Piped medical gases in ambulance vehicles’
- National Health Service Model Engineering Specification C11 – ‘Medical gases’
- European Pharmacopoeia standards for medical gases, including medical compressed air
- *[Premises]* health and safety policy
- *[Premises]* fire policy
- Any other relevant local guidance.

Appendix C – Sample MGPS maintenance contract

Form of contract

There are essentially three parts to a maintenance contract:

- a. An introductory section which gives the Contractor overall details on contract conditions and pricing. This is often combined with an invitation to tender for the work.
For example, the sample contract presented below could be prepared as part of a tender documentation package by adding in section 1:
“Contractors are invited to submit a (fixed price) quotation for the maintenance of the MGPS installed within _____ Trust premises.
The Contractor is required to undertake all works as described in this specification.”
- b. The “particular specification”, which gives the Contractor more detail of the requirements of the maintenance requirements and expectations of the customer and may cover such detail as capability of the Contractor.
- c. The “schedule of work”, which lists all equipment on which the maintenance is to be performed and details the level(s) of task for each item.

Contract for the maintenance of medical gas pipeline systems installed in _____ (premises)

1. General

- 1.1 The enclosed plan shows the site for which this specification is applicable. Not all buildings on this site contain medical gases.
- 1.2 Medical gas pipelines fitted on this site deliver:
 - a. oxygen;
 - b. nitrous oxide;
 - c. nitrous oxide/oxygen mixture;
 - d. medical air 400 kPa;
 - e. surgical air 700 kPa;
 - f. medical vacuum.
- 1.3 The Contractor will be required to complete and sign _____, a copy of which is attached to this specification.
- 1.4 This specification is subject to _____ Trust’s “Standard terms and conditions for the provision of a works service” and “Health and safety arrangements for the control of estates contractors and estates personnel”, copies of which are attached.
- 1.5 **Contract period.** This maintenance contract will be for a _____ calendar year period starting from _____.
This may be extended by _____ Trust by a further _____ years to a maximum of _____ years.

- 1.6 Contract cost.** The Contractor is required to submit a completed cost summary form (copy attached) and must identify costs for a _____ year period, the first year of which is to be at a fixed price. Subsequent years may be allocated a revised fixed price or a variation index, based on the first-year price. The cost submitted by the Contractor should relate to details of work to be undertaken given in “schedule of works” at the visit frequency given in paragraph 1.9 below. The contract price should allow for the additional work required to check the schedule of equipment against as-fitted equipment and identifying any deficiencies, as part of the first service visit.
- 1.7 Contract cancellation.** At the end of the first _____ months, either party giving _____ months’ notice in writing may cancel the contract.
- Failure by the Contractor to meet the requirements set out under “particular specification” below will result in termination of the contract by _____ Trust, by the serving of _____ month’s notice at any time during the contract period.
- 1.8 Technical standards.** All works undertaken by the Contractor must comply with Health Technical Memorandum 02-01 and any relevant Supplement(s) (all latest editions). No variations to these publications should be made, unless specifically authorised in writing by estates services. _____ Trust.
- 1.9 Service visit frequency.** Maintenance visits by the Contractor will take place on a _____ monthly basis on the following dates: _____
- Work must commence within _____ days of these dates and must be completed within _____ days of these dates.
- 1.10 Emergency interruptions.** With the exception of unforeseen emergencies, which will be monitored by _____ Trust estates services, each contracted maintenance visit as described in the particular schedule should be undertaken as one continuous visit to site.
- 1.11 Contractor’s personnel.** The Contractor should employ maintenance staff performing the work as described.
- No subcontracted staff will be employed on _____ Trust premises without the express permission of estates services.
- It is the duty of the Contractor to ensure the competence of personnel undertaking this work.
- _____ Trust reserves the right to request the removal of any member of the Contractor’s staff who is deemed by _____ Trust to be unsuitable to be working on trust premises. No reason need be given for this decision.

2. Particular specification

- 2.1** This particular specification relates to the medical gas pipeline systems as described in 1.2 above, and should require the Contractor to undertake the maintenance as described under “schedule of work” on the following systems:
- all terminal units, however mounted;
 - all alarm systems associated with the medical gas systems;
 - all visible medical gas pipelines and their means of isolation;
 - all manifolds, including emergency reserve and stand-by units;
 - all medical/surgical air compressors and vacuum plant;
 - all AGSS.
- 2.2** The Contractor is to include for all sundry items regardless of any maintenance frequency required as part of the routine maintenance.
- 2.3** All work should be undertaken during normal working hours, Monday to Friday 08.00 hours to 17.00 hours. Where this is not possible because of occupation of buildings (for example operating rooms), the Contractor should liaise with the Authorised Person (MGPS) to arrange convenient visiting times.

2.4 Call-outs for repairs during normal working hours must be quoted accordingly.

2.5 Exclusions. The contract price will not include:

- a. work required to be undertaken as a result of damage to the system, unless caused by the Contractor;
- b. call-outs for repairs outside normal working hours;
- c. routine maintenance work, where this cannot be accommodated within normal working hours;
- d. materials, other than those identified in **paragraph 2.2** above.

2.6 The Contractor should provide an emergency call-out facility for the request of work outside normal working hours.

2.7 The call-out response time should be a maximum of ____ hours at all times.

2.8 The Contractor's representative should report to the Authorised Person (MGPS) on each arrival on and departure from site.

2.9 All Contractor's staff must wear personal identity badges provided by the Contractor and visitors' badges provided by ____ Trust at all times they are on trust property.

2.10 In the event of the Contractor finding defects in the medical gas systems, other than those needing minor repairs, the Contractor will draw these to the attention of the Authorised Person (MGPS) who, where appropriate, will raise the necessary order for the repair works. No such work should take place without the knowledge and permission of the Authorised Person (MGPS).

2.11 At the end of each service visit the Contractor should provide the Authorised Person (MGPS) with a report detailing the work.

This report should be signed by the Contractor's representative undertaking the work and must be submitted to the Authorised Person (MGPS) within ____ days of completion of the visit.

Self-adhesive "serviced" labels should be applied to each item of plant serviced. These labels will bear the date of service, the date of next service and the name of the service engineer.

In the case of terminal units, such labels will be fixed next to the valve box controlling these units.

2.12 Minor works. This contract applies only to the routine maintenance of the medical gas systems within ____ Trust.

On occasion, the Contractor may be required to submit tenders for work associated with minor alterations and improvements to these systems.

This contract does not imply exclusivity of the Contractor for undertaking these works.

____ Trust will seek competitive quotations for each piece of work.

2.13 Method statement. The Contractor should submit (with the quotation) a method statement detailing how the work listed in this specification is to be performed. This statement should include information on the anticipated length of time needed to undertake a maintenance visit, number of staff on site etc.

2.14 Capability statement. The Contractor should submit (with the quotation) a general statement on their ability to support the requirements of ____ Trust.

This should include details of various resources available to the Contractor, number of staff, competence levels, emergency support provision etc.

2.15 Documentation. The Contractor should provide:

- a. details of any other similar contracts being undertaken;
- b. a copy of the Contractor's registration certificate under BS EN ISO 9001/BS EN ISO 13485, with relevant scope for maintenance of medical gas systems defined;
- c. copies of calibration certificates for all test equipment used in this work;

- d. a list of Competent Persons (MGPS) who may be employed during this contract;
- e. copies of the training records of the above Competent Persons (MGPS);
- f. a copy of the Contractor's health and safety policy;
- g. a copy of the Contractor's method statement, including any relevant risk assessments;
- h. copies of any relevant test/record sheets used by the Contractor, including records of each service visit.

_____ Trust will provide the Contractor with additional up-to-date as-fitted drawings when necessary.

3. Schedule of work

Plant/systems on which the work is required (list).

(Detail of the work to be defined here, with due regard to manufacturer's data and the maintenance schedules detailed in this Health Technical Memorandum.)

Appendix D – Work on medical vacuum and AGS systems

Work on medical vacuum systems

This Appendix contains information on the following topics related to work on a medical vacuum system:

- working on vacuum terminal units, plant and pipelines, including pipeline removal;
- changing bacteria filters on medical vacuum plant;
- cleaning procedures for vacuum systems contaminated with aspirated blood products etc.

It should be noted that these procedures do **not** apply to any work on high-risk vacuum systems that may be installed in infectious disease units. This Health Technical Memorandum does **not** recommend the use of piped vacuum systems in such areas, but where these have been installed, special protocols for the work described in this Appendix must be drawn up at local level by infection control and health and safety personnel. These special protocols should also cover work on portable suction units used in infectious disease units.

Work on medical vacuum terminal units, plant and pipelines

The basic hygiene procedures outlined in this Appendix will suffice for most work on medical vacuum systems, including removal of redundant pipework.

However, if pipework or plant to be removed is known to have been contaminated by aspirated blood, body fluids or toxic agents, the advice of the infection control officer should be sought. The protective measures described for changing bacteria filters may need to be used when removing contaminated plant or pipework.

Waste oil and condensate from vacuum pumps and exhaust traps should be disposed of as “hazardous waste” in accordance with hospital procedures.

Changing bacteria filters on medical vacuum plant

Before carrying out the work, advice should be sought from the user on any toxic or infectious materials that may have entered the system.

If it is apparent that occupational exposure limits (OELs) for toxic substances may be exceeded, the safety officer should be advised, and an appropriate air-fed respirator should be used.

All staff, including contractors, should observe local safety procedures as set out in the trust’s safety policy.

Note: use of additional permit

The MGPS permit-to-work in this Health Technical Memorandum can be used for general work on vacuum systems. However, previous editions of this Health Technical Memorandum have prescribed the use of an additional permit when changing bacteria filters, as this second permit allows for the intervention of the infection control/health and safety officer in cases where additional infectious/toxic hazards have been identified.

Preparing for the work

Two heavy-duty polythene bags will be required.

All staff should wear the following protective clothing when carrying out a filter change:

- disposable mask;
- disposable apron, which should be discarded after use in the outer bag for disposal;
- disposable gloves made of strong latex or other non-allergenic material;
- safety goggles.

Disposable overshoes should be worn if required by the hospital.

Filter and protective clothing disposal

The used filter is placed directly into a heavy-duty polythene bag, which is then sealed.

This bag is placed, with the gloves, mask and overalls, inside a second bag, which is also sealed and labelled: “Clinical waste – to be incinerated”.

The staff carrying out the filter change should notify the waste disposal department and/or the Authorised Person (MGPS), as appropriate, so that bags can be collected and disposed of.

A sample permit, for use with the MGPS permit, a standard operating procedure for filter changes and a filter change procedure suitable for posting on/near vacuum plant are shown on the following pages.

Hospital	Permit No 06/V6789
PERMIT-TO-WORK Bacteria filter replacement – Central medical vacuum plant	
Location of plant	Plant No
Area served	
I hereby authorise to remove and replace: LEFT/RIGHT/BOTH bacteria filter(s) on the above plant and dispose of the used filters in accordance with hospital policy. The work will take place on: DATE at: TIME SIGNED PRINT NAME Authorised Person (MGPS) DATE TIME	
Additional hazards have been identified as: TOXIC INFECTIOUS SIGNED PRINT NAME Infection Control Officer DATE TIME	
I accept responsibility for carrying out the above filter change(s) according to the procedure detailed in Health Technical Memorandum 02. I am familiar with safety policies relevant to this task. SIGNED PRINT NAME Competent Person (MGPS) DATE TIME	
I declare that I have completed the work described above and have informed the Authorised Person (MGPS). SIGNED PRINT NAME Competent Person (MGPS) DATE TIME	
I confirm that the above work has been carried out to the required standard and the plant is fully operational. SIGNED PRINT NAME Authorised Person (MGPS) DATE TIME	

Original (white) copy to be retained in book by Authorised Person (MGPS)
 Blue copy to Infection Control Officer
 Yellow copy to Competent Person (MGPS)

HTM 02-01 PW3 Ver 1.0

Medical vacuum systems: bacteria filters Standard operational procedure for filter changing

Warning!

The vacuum system must be considered potentially contaminated and you must take the precautions listed below

If you observe any suspicious contaminant, such as mucus or blood, stop work immediately and report the situation to the Authorised Person (MGPS).

Biological contamination may appear crystalline or organic. Do not be deceived by appearance; treat all foreign material as a possible hazard.

Do not commence any work on a vacuum system suspected of contamination without authorisation and guidance from the Authorised Person (MGPS).

Do not eat or smoke when working on vacuum systems or components.

Do before putting on waterproof gloves, inspect your hands carefully for cuts or abrasions. Apply a waterproof dressing as necessary to effectively cover all lesions.

Do wear the waterproof gloves provided and ensure that they remain intact throughout all work stages.

Do wear standard-issue overalls and ensure that they remain fully buttoned.

Do wear eye protection, the face mask and disposable plastic apron provided.

Do wear all protective clothing throughout all work stages.

Do take care not to cut yourself. If you do happen to cut yourself, carry out the following procedures:

1. If a glove is punctured, remove glove.
2. Allow wound to bleed freely.
3. The contaminated area should be washed gently under running water and not scrubbed.
4. Inform the Authorised Person (MGPS) of the incident immediately.
5. Seek medical advice on appropriate action, for example the need to administer hepatitis B vaccine.
6. Report the incident in accordance with local or company rules.

Do dispose of all removed infected material and oil in accordance with hospital procedures, for example sealed within a bag marked “contaminated” and entrusted to the hospital authorities for safe disposal.

Do request guidance from the Authorised Person (MGPS) if in doubt about disposal procedures.

Do not remove contaminated materials from site.

Do not dispose of potentially contaminated material in ordinary rubbish bins.

Do not place contaminated tools or equipment into your toolbox.

Do immediately, on completion of work, remove any contaminated outer clothing and always wash your hands and, if necessary, contaminated tools in an approved disinfectant; then rinse under running water.

Warning

Potentially contaminated material must not be blown through an open-ended pipeline.

Bacteria-filter change procedure

[to be affixed on/near plant]

1. Select “stand-by” bacteria filter for on-line use. Select the bacteria filter that is not going to be changed by fully opening the inlet and outlet isolating valves.
2. Isolate the “in-use” bacteria filter. Isolate the bacteria filter that is going to be changed by fully closing the inlet and outlet isolating valves.
3. Isolate the “in-use” drainage flask. Close the drainage flask’s manual isolating ball valve.
4. If any liquid is present, inform the Authorised Person (MGPS) immediately; otherwise, remove the drainage flask.
5. Remove the filter housing. Unscrew/unclamp the filter housing and remove.
6. Remove the filter and place in a disposal bag.

Warning

**Filter elements cannot be cleaned or re-used.
Dispose of in accordance with hospital procedures for contaminated waste.**

7. Fit the filter element. Position the O-ring seal and filter element. Secure the element within the filter head seat. Position the lower O-ring seal in the element-retaining nut, locating the groove. Fit the element-retaining nut and tighten by hand.

Caution

**Do not over-tighten the filter element
as distortion of the O-ring seals may occur and prevent an effective seal.**

8. Refit the filter housing. Ensure that the O-ring seal is correctly positioned on the filter housing. Fit to the filter head and tighten. Do not over-torque.
9. Refit the drainage flask. Screw the flask back onto the adapter, ensuring the O-ring is compressed to form a seal.
10. Open the flask’s manual isolating valve.

Vacuum system decontamination

Suction controllers are fitted with integral filters and floats to prevent aspirated fluids from passing into the vacuum system pipework. Additionally, fluid drainage jars are fitted with floats and are often used in conjunction with an anti-foaming agent to prevent carry-over.

Drainage jar-to-suction controller tubing is frequently protected by the addition of a hydrophobic filter, which will effectively seal the tube should the filter become wet.

Contamination of the medical vacuum distribution system may result, however, if one or more of these features is omitted or compromised in some way.

Repetitive induction of fluids can cause a blockage of the pipeline as transported and dissolved solids dry out.

It is important that the Authorised Person (MGPS) is notified immediately of any incident involving contamination of the pipeline. Medical staff should be aware of their responsibilities in this respect, and infection control should also be advised of any contamination incident.

Removal of system contaminants requires the use of a detergent/disinfectant solution, which is aspirated via terminal units/NIST connectors. Savlon or Teepol can be used.

Satisfactory results have been obtained by using Savlon in hot water, with an appropriate quantity of sodium dichloroisocyanurate sterilizing tablets added.

Previous decontamination procedures have recommended circulation of the cleaning fluid towards the central plant using the system vacuum. However, if it is possible to circulate the fluid via terminal units and a local AVSU NIST connector, using a pump, this method is to be preferred, as it will limit contamination to the local pipework. This is particularly important in older systems employing terminal unit drops from beneath distribution pipework, rather than the up-and-over arrangement prescribed in this Health Technical Memorandum.

There may be instances where blockage is so severe as to cause complete restriction of the pipework. In these circumstances, the risks associated with using high pressure fluid pumps must be weighed against the disruption that will result from pipework removal and replacement.

If pumps are to be used, fluid should be fed into the system via the upstream NIST connector of the AVSU serving the area (with the AVSU isolated) and extracted via the contaminated terminal unit(s).

Procedure for vacuum system decontamination using the system vacuum

- a. Authorised Person (MGPS) to be advised of incident.
- b. Authorised Person (MGPS) arranges permit-to-work for taking other downstream terminal units out of service if possible.
- c. Establish, in consultation with surgical or clinical practitioners, the possible nature and volume of the contaminant.
- d. Consult the infection control officer to ascertain the level of microbiological hazard, including the pathogenicity and persistence of any infectious agents.
- e. From a study of the as-fitted drawings, identify any downstream terminal units that may be flooded during the cleaning process.
- f. A solution of 1% Teepol or Savlon plus sodium dichloroisocyanurate in about 10 L of hot water should be prepared.
- g. Aspirate 1 L of solution through the terminal unit immediately upstream of the contaminated unit and leave with a low flow via suction controller.
- h. Aspirate 5 L of solution via the contaminated terminal and leave with low flow.
- j. Aspirate 0.5 L through each of the next ten or so units and leave with low flow.
- k. Check other downstream terminal units for presence of solution. Where found, repeat the procedure.
- m. Repeat the whole procedure using clean hot water.
- n. Take the system back into use.
- p. Check plant filters for evidence of fluid.
- q. Where present, change the bacteria filters (see procedure).
- r. Monitor the system for a few days, with vacuum control units fitted, for evidence of liquid.

Procedure for vacuum system decontamination using a fluid pump

- a. Authorised Person (MGPS) to be advised of incident.

- b. Authorised Person (MGPS) arranges permit-to-work for isolation of local AVSU.
- c. Establish, in consultation with surgical or clinical practitioners, the possible nature and volume of the contaminant.
- d. Consult the infection control officer to ascertain the level of microbiological hazard, including the pathogenicity and persistence of any infectious agents.
- e. From a study of the as-fitted drawings, identify any downstream terminal units that may be flooded during the cleaning process.
- f. A solution of 1% Teepol/Savlon/sodium dichloroisocyanurate in about 10 L of hot water should be prepared.
- g. Using the fluid pump, circulate disinfectant solution via the AVSU NIST connector through the system to exit via the contaminated terminal unit (which is fitted with a suitable open probe and disposal hose).
- h. Other downstream terminal units should be checked for presence of solution. Where found, each should be flushed in a similar manner.
- j. Repeat the procedure using clean hot water.
- k. Ensure that the pump removes as much water as possible from the system.
- m. Take the system back into use, leaving the cleaned terminal units with a low flow via suction controller regulators.
- n. Check plant filters for evidence of fluid.
- p. Where present, change the bacteria filters.
- q. Monitor the system for a few days, with vacuum control units fitted, for evidence of liquid.

Work on anaesthetic gas disposal systems

Bacteria filters are not usually included in the air pathway of AGSS pump units, and may also be absent from the patient breathing circuit exhaust.

Given the high flow rates in such systems, condensation of moisture in the pipework between terminal units and pumps is unlikely.

Some condensation may occur in the exhausts of AGS systems if these are subject to low ambient temperatures; but risks arising from potentially contaminated condensate are low, as the need to work on exhausts is generally small.

If condensate is detected in the exhaust drain flasks, causes for its formation should be investigated and remedial action taken if appropriate. This condensate should be considered and disposed of as “hazardous waste”.

However, even without detectable condensation, microbiological contamination of AGS pipelines is not unknown, and unnecessary exposure should be avoided.

Basic hygiene procedures should be observed when working on terminal units, plant and pipelines (that is, covering of all lesions with waterproof dressings; washing of hands after carrying out the work; abstaining from eating, drinking or smoking when carrying out the work; and taking remedial action as described in the bacteria-filter changing procedure above) in case accidental wounds occur during the work.

Only in extreme cases (for example known serious pathogenic contamination of the system) would further actions be required. In such cases, the advice of the infection control officer should be sought.

Appendix E – Authorised Person (MGPS): summary of specific duties with regard to VIE installations

This Health Technical Memorandum defines the role and responsibilities of the Authorised Person (MGPS) with respect to the permit-to-work system and other MGPS duties.

However, there are specific duties associated with the management of cryogenic oxygen supplies. These are summarised below. (This is not an exhaustive list.)

- a. Liaison with the gas supplier to ensure the most cost-effective solution to the hospital's oxygen supply requirements. This will involve the Authorised Person (MGPS), the hospital's risk manager, the chief pharmacist (or Quality Controller (MGPS) representative), an appropriate clinical representative, and a representative of the potential medical gas supplier in the risk assessment process detailed in this guidance. Consideration will need to be given to items such as the siting of the installation and the environmental impact of vehicular deliveries, provision of high power electricity supplies to the compound (if required by the gas supplier), compound lighting and safety, and any roadway modifications that may be required if larger delivery vehicles are to be used. The risk assessment protocols in this guidance should be followed in full, but there may be other considerations, relevant to a particular site, that are not mentioned here.
- b. Assimilation of telemetry data and responding to abnormal levels of liquid consumption, vessel pressure etc.
- c. Responsibility for agreeing the final location of the liquid oxygen compound(s), taking into consideration any issues raised in the initial risk assessment. This will involve confirmation of compliance with all relevant health and safety issues concerning the installation, and agreeing (in writing) with the trust's health and safety officer and the gas supplier's safety representative any relaxation of these requirements (for example safe separation distances). Both parties must ensure that an equivalent level of safety is achieved, and this should be approved and documented.
- d. Providing technical information and training to directly managed staff who may be involved with the installation and who have not already been trained by the gas supplier in the safe operation of the plant.
- e. Providing advice to the trust on the operational management consequences of using different suppliers to supply medical oxygen to the different supply systems on the same pipeline system. Any contracts involving different suppliers should clearly state the obligations and limitations of liabilities. There may also be management consequences involved in situations where one VIE system is used to supply more than one hospital. In particular, management responsibilities of Authorised Persons (MGPS) for each site and insurance implications will require clarification. The gas supplier must provide a clear description of its insurance liability for the supply equipment, and the individual hospitals must define liability in the event of an incident arising from gas supply failure or contamination.
- f. Responding safely to emergency conditions on plant or pipeline systems, such as to avoid undue or inadvertent interruption to supplies, wastage of product, or dangerous situations.
- g. Ensuring that all safety signage, lighting and anti-personnel protection required for the installation is in place and maintained. A piping and instrumentation diagram of the plant should be displayed clearly to indicate the appropriate valves that are necessary to operate the plant safely.
- h. Ensuring that the VIE compound(s)/manifold rooms remain(s) locked at all times, other than for essential maintenance and product delivery. Any key or lock combination should be made available to appropriate personnel for maintenance and routine or emergency product deliveries, including those outside normal office hours. Any key control system should be documented in the MGPS operational policy.
- j. Ensuring that, in addition to the routine maintenance and testing performed by the gas supplier, the basic maintenance detailed in [Chapter 10](#) is carried out and recorded.

Appendix F – Valve numbering schedule and valve status of British Oxygen Company's (BOC) and Air Products' liquid oxygen cryogenic storage vessels

Table A1 Valve numbering schedule

Valve control function	Valve no (BOC)	Valve no (AP)	Operating condition
Trycock	V4	V4	NC
Economiser (gas take-off from vessel)	V5	V22	NC
PSV/bursting disc changeover	V6	V21	NO
Liquid feed to main evaporator	V7	V14	NO
Gas return from pressure-raising evaporator*	V9	V12	NO
Liquid feed to pressure-raising evaporator*	V11	V3	NO
Top fill	V12	V2	NC
Bottom fill	V13	V1	NC

Key:

BOC = British Oxygen Company
 AP = Air Products
 NO = normally open
 NC = normally closed

Notes:

* On an AP tank, the pressure-raising evaporator is known as the pressure-building unit (PBU).

AP tanks are also fitted with a valve numbered as V13. However, this is not a bottom-fill valve. It is a vent valve in the feed line to the PSV/bursting disc station changeover valve (V21). Some BOC tanks have a similar vent valve, numbered V20. This vent valve, which is normally closed, can be opened to lower tank pressure in an emergency.

Table A2 Valve status in normal and emergency operating conditions

Condition	Valve status															
	V4 BOC	V4 AP	V5 BOC	V22 AP	V6 BOC	V21 AP	V7 BOC	V14 AP	V9 BOC	V12 AP	V11 BOC	V3 AP	V12 BOC	V2 AP	V13 BOC	V1 AP
Normal liquid take-off	NC		NC		NO*		NO		NO		NO		NC		NC	
Normal gas take-off	NC		NO		NO*		NC		NO		NO		NC		NC	
Safety valve lifting	NC		NC		NO*		NO		NO		NC**		NC		NC	
Bursting disc rupture	NC		NC		NO*		NO		NO		NC**		NC		NC	
Fire in hospital	NC		NC		NO*		NO		NO		NO		NC		NC	

Key:

BOC = British Oxygen Company
 AP = Air Products
 V = Valve number
 NO = normally open
 NC = normally closed

Notes:

* V6 BOC (V21 AP) will be open to one set of safety valves plus bursting disc. It will be changed over when the tank pressure has returned to normal, following safety-valve or bursting-disc rupture. V6/V21 must not be changed over until pressure has returned to normal.

** V11 BOC (V3 AP) will be shut to help lower high vessel pressure, but will be reopened when pressure has returned to normal.

Appendix G – Notes on use of Permit books

Permits are now divided into two hazard levels: **high** and **low**. The medium hazard level was little used and has been removed.

- High hazard work is that involving risks of cross-connection and pollution of medical gas systems.
- Low hazard work is all work not considered to be high hazard work and carries no risks of pollution or cross-connection.

Medium hazard work was previously defined as work carrying risks of cross-connection, but which posed only a small risk (or no risk) of pollution, and was embodied by work on non-BS/EN-designed terminal units (for example BOC Mark 1 types in which seal replacement necessitated isolation of a supply to a ward where these terminal units were to be serviced). The non-gas-specific nature of components in such terminal units means that accidental exchange of components during re-assembly of the terminal units is possible (tests to prove absence of inadvertent cross-connection are carried out on completion of the work).

Where terminal units containing non-gas-specific components remain in use, and on occasions when the Authorised Person (MGPS) identifies a possible risk of cross-connection (for example hose replacement), it will still be necessary to carry out such anti-confusion tests as are necessary to detect possible cross-connection of component parts.

The Authorised Person (MGPS) may well carry out such tests mechanically, for example by the use of proofing tools/probes, intervention by the Quality Controller (MGPS) being unnecessary. On occasions where the Authorised Person (MGPS) considers that the risk of cross-connection warrants a deeper level of testing, the Quality Controller (MGPS) may be asked to carry out a formal gas identity check. In the former example, the work would be covered under a low hazard permit; in the latter, the work would be covered under a high hazard permit, as work by the Quality Controller (MGPS) is required.

Some work may involve isolation of a ward's gas supply (for example servicing "non-standard" terminal units,

servicing terminal units known to have an inherent history of automatic isolating valve failure, or changing pressure switches). It is incumbent on both the Authorised Person (MGPS) and the Competent Person (MGPS) to ensure that all possible precautions are taken against unwanted isolation of other parts of the system. In these instances, it is essential that an up-to-date set of as-fitted drawings is made available.

When carrying out isolations for high hazard work, it will now be necessary to provide, as part of the permit, a schematic diagram showing the area, gases and valves involved in the isolation. If the Authorised Person (MGPS) considers that isolation of a ward prior to servicing terminal units involves additional risks because of, say, isolating valve position, a similar schematic should be drawn up and kept with the low hazard permit. If actual drawings/schematics of the intended point of isolation are not available or inconvenient to include with the permit, advantage should be taken of the fourth sheet in the permit set, on which a sketch should be drawn.

The low hazard permit will not require the signature of a Designated Medical Officer/Designated Nursing Officer (MGPS). This has long been adopted practice for such work as plant oil and filter changes, but is now formalised in Health Technical Memorandum 02-01. However, if interruption of gas supplies to terminal units is part of the low hazard work, the Authorised Person (MGPS) must obtain the written permission of either a Designated Medical Officer or a Designated Nursing Officer (MGPS).

Previous editions of Health Technical Memorandum 02 have described the use of work dockets as an alternative to the permit (for example for routine planned preventive maintenance work or for work on cryogenic liquid systems). This is no longer considered good practice – **permits should be issued for all work on MGPS, including cryogenic systems**, with the exception of the few situations listed in **Chapter 6** of Part B of Health Technical Memorandum 02-01, that is:

- emergencies;
- replacement of cylinders/recharging of cryogenic liquid storage vessels;

- commissioning of a new MGPS;
- quarterly quality control testing of medical and surgical air.

Summary of engineering and pharmaceutical tests

Tests and checks on the pipeline carcass

The following tests must be carried out after installation of the pipeline carcass, but before concealment:

- visual check of pipeline labelling, marking, sleeving and support;
- leakage test;
- tests for cross-connection;
- valve tests for closure, zoning and leakage (these tests will be repeated as part of the pipeline system tests, and the contractor may wish to defer closure and leakage, but may choose to carry out a zoning check).

Tests on the pipeline system

The following tests and checks must be carried out after complete installation of the pipeline system:

- tests for leakage on each MGPS;
- tests of AVSUs for closure, correct service and control of the terminal units in the zone: checks for correct labelling of AVSUs for zone reference and identity of terminal units controlled and flow direction indication;
- tests of line valve assemblies (LVAs) for closure and identification;
- tests for cross-connection, flow, pressure drop, mechanical function and correct identity of the terminal units: checks for correct labelling for zone identification (this is only required when, within a specific area, there are separate circuits for the same service, for example dual/split circuits);
- tests for mechanical function and identity of NIST connectors;
- performance tests of the pipeline system;
- functional tests of all supply systems;
- checks of safety valve certification;
- tests of warning systems;
- tests for particulate contamination/odour/taste.

These tests may be carried out immediately after installation using medical air, or after purging and

filling with the specified gases. The aim is that a system purged clear of gross particulate contamination should be handed over to the Quality Controller (MGPS) **before** it is filled with the working gases. However, it is accepted that this may not always be possible. If the system is not to be taken into immediate use, the tests for particulate contamination and odour/taste should be carried out with medical air, and the system then left under pressure;

- tests for anaesthetic gas scavenging disposal systems.

Tests before use

The following tests must be carried out after purging and filling with the working gas:

- test for particulate contamination;
- tests for gas identity;
- tests for gas quality.

Note that pipeline odour tests will not usually be carried out on nitrous oxide, carbon dioxide or Entonox/Equanox/Oxynox systems when carrying the working gases.

Suggested coding system for recording tests performed during validation/verification process

High hazard permits

Given the small amount of space allocated in part 3 of the permit for written description of the engineering validation/verification tests, the following coding system may be used as an alternative method of indicating the tests completed. The prefix “C” is used to indicate carcass tests, and “S” is used to indicate system tests, as defined in Health Technical Memorandum 02-01.

Should a test not covered by the coding system be applied at the discretion of the Authorised Person (MGPS), it will be necessary to insert a description of the test as concisely as possible into part 3 of the permit form.

The basic coding scheme applies to an addition to an existing system; that is, the tests described are carried out on the additional pipework in accordance with Chapter 15, Part A, of Health Technical Memorandum 02-01.

If the work is the repair/service/maintenance of a system, the test methods may vary from those in Chapter 15. For example, it may not be possible to apply a high pressure test to pipework that has been inserted to replace a damaged section; a simple “soapy water” test could be used. Analogously, the leakage test performed on the

replaced section is not likely to be the high pressure test performed on a carcass, as the repair is to a “system”; a simple soapy water leak test at the working pressure and with the working gas will often suffice.

To indicate these different test methodologies, a “V” should be added as a suffix to the appropriate code (see examples in the table).

Time of test for leak detection can be added as a numeral, indicating the number of hours on test. A simple soapy water test would be indicated as a zero (see examples in the table).

This system may be extended as required, but all staff working with the permit system should be given a copy of the chosen codes.

Low hazard permits

As tests are for a wide range of plant etc but are generally limited to confirmation of performance/function, it is considered that application of a coding system here will most likely add unnecessary complication to the task of recording tests. Therefore, a simple description of the test will suffice.

Use of the fourth sheet of a high hazard permit

An increase in the number of inadvertent isolations has prompted inclusion of a fourth (green) sheet in the high hazard permit book.

On this sheet, the Authorised Person (MGPS) should provide a sketch of sufficient detail to ensure that safe isolation can take place (for example showing the AVSU/LVA to be isolated, its inlet (with source indicated) valve number, key number, together with any safety warnings). Following discussion with the Competent Person (MGPS), both Authorised Person (MGPS) and Competent Person (MGPS) should sign the sheet, which is then retained in the permit book.

Isolation should **not** take place until the sheet has been completed and signed off.

Description of test	Code letters for use in part 3 of permit	Notes
Carcass tests		
Labelling and marking	CLM	
Sleeving and supports	CSS	
Leakage (at high pressure)	CLH	
Cross-connection	CCC	
Valve closure, zoning, leakage	CAC, CAZ, CAL	
System tests		
Leakage (at working pressure)	SLX (SL0V)	(SLX) indicates working pressure test of section, where X = No of hours on test (SL0V) would indicate a soapy water test only.
Closure of AVSUs and LVAs	SAC (SACV)	(SACV) indicates a closure test on a repaired AVSU/LVA.
Zoning of AVSUs and terminal unit identification	SZT	
Cross-connection	SCC (SCCV)	(SCCV) indicates that a full cross-connection test was not performed i.e. during repair of one (only) gas system, all other systems remained at full working pressure.
Flow and pressure drop at individual terminal units, mechanical function and correct installation	SFP (SFPV)	(SFPV) indicates that flow rate and pressure drop measurements were taken but with the system operating during working, not design, conditions. This could be a check of terminal unit performance after additions to part of the system, or repair to/maintenance of, terminal units.
System performance	SSP (SSPV)	(SSPV) indicates that a test has been performed on the existing system after connection of additional terminals etc, and is, in effect, confirmation that overall system performance has not been affected by the work. It is unlikely that a full system performance test (SSP) as prescribed in Health Technical Memorandum 02-01 will be performed every time additional terminal units are added; the methodology of this test is, therefore, at the discretion of the Authorised Person (MGPS).
Supply systems	SSS (SSSV)	(SSSV) indicates a test of repaired, rather than new, plant.
Pressure safety valves	SPS (SPSV)	(SPSV) indicates visual confirmation of conformity of a replacement PSV rather than new PSV fitted in an extended part of a system.
Warning and alarm systems	SWA	
As-fitted drawings	SAF	

Description of test	Code letters for use in part 4 of permit	Notes
Purging and filling with working gases	SPF	Note that this test appears in part 4 of a high hazard permit, as the Quality Controller (MGPS) will normally conduct it. As such, coding is unnecessary in this part of the permit. If the system is offered to the Quality Controller (MGPS) as “purged and filled”, the code would appear in part 3 of a high hazard permit, although this would only be allowed at the discretion of the Quality Controller (MGPS).
Particulate contamination and odour	SPO	Note that particulate and odour tests could be recorded in part 3 of the high hazard permit if these tests are completed before filling with the working gases. The tests could also appear in part 4 of the high hazard permit if carried out after filling with the working gases or as a repeated test at the discretion of Quality Controller (MGPS).
AGS disposal systems performance (at terminal unit)	SDT	
AGS disposal systems performance (full test)	SDF	

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