NHS National Services Scotland

Medical Gas Pipeline Systems

Scottish Health Technical Memorandum

Part B - Operational management

SHTM 02-01 Part B

Draft 1.02 - November 2025.

Contents

Preface

About Scottish Health Technical Memorandum

Scottish Health Technical Memorandums (SHTMs) 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 SHTM 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.

Language usage in technical guidance

In SHTMs verbs such as “must”, “should” and “may” are used to convey notions of obligation, recommendation or permission. The choice of modal verb will reflect the level of obligation needed to be compliant.

The following describes the implications and use of these modal verbs in SHTMs (readers should note that these meanings may differ from those of industry standards and legal documents):

A. “Must” is used when indicating compliance with the law
B. “Should” is used to indicate a recommendation (not mandatory/ obligatory), for example among several possibilities or methods, one is recommended as being particularly suitable - without excluding other possibilities or methods
C. “May” is used for permission, for example to indicate a course of action permissible within the limits of the SHTM
D. “Shall”, in the obligatory sense of the word, is never used in current SHTMs

Typical usage examples

A. “All pipeline components must be clean for oxygen service.” [obligation]
B. “This document makes recommendations for the allocation of duties to personnel and the manner in which these duties should be performed.” [recommendation]
C. “Further advice on the application of this guidance may be obtained from the Authorising Engineer (medical gas pipeline systems (MGPS))” [permission]

Project derogations from the Technical Guidance

Healthcare facilities built for the NHS are expected to support the provision of high-quality healthcare and ensure the NHS Constitution right to a clean, safe and secure environment. It is therefore critical that they are designed and constructed in accordance with appropriate technical standards and guidance. This applies to all new and refurbishment projects, regardless of procurement model.

Note 1: The healthcare organisation, and their project teams, should ensure that they have a fully documented list of technical standards and guidance that are applicable to the specific project.

The starting point for all NHS healthcare projects at Project Initiation Document (PID) and/ or Strategic Business Case (SBC) stage is one of full compliance.

It is recommended that the starting point for all projects should be one of full adherence to the SHTM guidance. While it is recognised that derogations may be required in some cases, these must all be risk-assessed and documented in order that they may be considered within a structured derogation review and approval process. In all instances derogations must not compromise the health and safety or operational resilience of the healthcare facility. Healthcare organisations should ensure that any derogations do not impact on their legal or statutory obligations.

Derogations must be properly authorised by the project's Senior Responsible Officer (SRO) and informed and supported by appropriate technical advice including that of the Medical Gas Safety Group (MGSG), irrespective of a project's internal or external approval processes.

A schedule of derogations should be created for any project, including details of approvals, risk assessment and identified mitigations.

Note 2: This guidance does not alter the healthcare organisations legal or statutory obligations.

NHS Scotland Sustainable Development Policy Drivers

Responding to the global climate emergency is one of the Scottish Government's highest priorities. Sustainable development, the concept that the needs of the present must be met "without compromising the ability of future generations to meet their own needs" is integral to the Scottish Government's overall purpose. The Scottish Government's National Performance Framework (NPF) shares the same aims as the United Nations' Sustainable Development Goals. It highlights the need for a 'whole system approach' to

successfully deliver the NPF's national outcomes for Health and recognises the important role that NHS Scotland has in helping to achieve this.

Over recent years the current and future impact of climate change has been well documented, with risks to human health and to health and social care delivery highlighted within Scotland's summary report of the UK Climate Risk Independent Assessment. For more information, visit the UK Climate Risk website for the Climate Change Risk Assessment (CCRA) Evidence Report Scotland Summary. NHS Scotland is committed to the delivery of a high quality, environmentally and socially sustainable health service that is resilient to the locked-in impacts of climate change. Director Letter (DL) (2021) 38 'A Policy for NHS Scotland on the Climate Emergency and Sustainable Development' provides the framework for this aim to become a reality, and to maximise NHS Scotland's contribution to mitigating and limiting the effect of the global climate emergency.

Executive Summary

Status

This 2025 version of Scottish Health Technical Memorandum (SHTM) 02-01 Part B supersedes all previous versions of SHTM 02-01 Part B 'Medical gas pipeline systems - Operational management.

General

Guidance in this SHTM (Part B) covers piped medical gases, medical air (MA) and surgical air (SA), and medical vacuum (MV) installations: it applies to all medical gas pipeline systems (MGPS) installed in healthcare premises including anaesthetic gas scavenging disposal systems. Specifically, it covers the design, installation, and validation and verification (testing and commissioning) of an MGPS.

Operational management

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

MGPS 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 MGPS 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.

Those 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. The operational policy 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, and the like.

The Authorised Person (MGPS) (AP (MGPS)) has a pivotal role in the preparation of the necessary documentation, for example the operational policy and its review and management, thereafter, operating the permit-to-work procedure, advising users about the systems and in the need for training of those staff with responsibility for the safe handling and changing of medical gas cylinders.

1. Scope

1.1. Throughout this document, the phrase ‘Part A’ is used as a generic term to describe the ‘Design, installation, validation and verification’ part of Scottish Health Technical Memorandum (SHTM) 02-01.

General

1.2. This part (Part B) of SHTM 02-01 covers the operational management and maintenance of systems for the supply of:

- medical oxygen
- nitrous oxide
- nitrous oxide/oxygen mixture (N_2O/ O_2:50%/ 50% v/v)
- medical air (MA) for respiratory applications (at 400 kPa) (medical air (4bar) (MA4))
- surgical air (SA) for tools (at 700 kPa) (SA7)
- medical vacuum (MV)
- carbon dioxide (CO_2)

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

1.3. Throughout this document, the ‘medical gas pipeline system(s)’ will be described by the term MGPS.

1.4. This guidance applies to all MGPS installed in healthcare facilities.

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. Existing installations should be assessed for compliance with this guidance document based on risk in accordance with British Standard (BS) European Standard (EN) International Standard (ISO) 14971 and the informed design process (IDP) risk assessment. The standard of safety should be to the same level that is given in this document. A plan for upgrading the existing system should be prepared if required, taking account of the priority for patient safety.

Operational management

1.7. 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.

1.8. 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.

1.9. The primary objective of SHTM 02-01 Part B is to ensure the provision of safe and reliable MGPS, and their efficient operation and use.

Medical gas safety group

1.10. The Medical Gas Safety Group (MGSG) is instrumental in the safe management of medical gases and development of the MGPS Operational Policy and provides assurance to the Medicines Management Committee that medical gases are effectively monitored and managed within the healthcare organisation.

1.11. The functions of the MGSG are to:

1. develop, review and update the Medical Gases Operational Policy and related policies and procedures, including these Terms of Reference, at agreed frequencies, or immediately on receipt of pertinent technical or clinical advice, including issue of safety alerts, hazard warnings and the like
2. promote and monitor that medical gas policies and procedures are implemented and adhered to throughout the healthcare organisation
3. assess training needs, implement training prescribed by SHTM 02-01 and monitor any non-attendance
4. co-ordinate education and training support to improve the quality of medical gas system management (including the MGPS permit-to-work system), incident reporting and safe working practices associated with the MGPS and patient-connected medical equipment
5. ensure that relevant competencies are in place and validated
6. act as a forum for monitoring medical gases risk management activities
7. promote staff participation in the prevention of accidents, incidents and near misses by identifying, developing and promoting best practices for medical gas safety. Implementation will require co-ordination and support for process and system changes, to reduce the likelihood of occurrence and/ or reoccurrence of serious (Medical Device) Incident Reports
8. disseminate information and provide feedback to appropriate groups, committees, staff and other stakeholders on medical gas related issues
9. act as an early warning mechanism to alert for emerging risks

10. receive the Authorising Engineer (MGPS) (AE (MGPS)) annual audit report and ensure remedial actions are carried out to the AE (MGPS) defined timescales
11. provide regular feedback to clinical staff, patient care areas and hospital committees on MGPS and medical equipment risks and planned actions to minimise these risks

1.12. For the MGSG to be quorate, a minimum of four MGSG members must be in attendance. Core members of the MGSG are expected to send appropriate representation to the meeting if they are unable to attend.

1.13. Other professionals will be co-opted onto the MGSG on occasions when specific topics are to be discussed.

1.14. The MGSG will meet (quarterly) but may convene additional meetings as appropriate.

1.15. The MGSG will report to, for example, the healthcare organisation via the Medicines Management Committee. Core MGSG members are responsible for providing feedback from meetings to their respective teams. The chair of the MGSG is accountable to, for example, the Chief Executive.

1.16. Meeting agendas will be distributed to all proposed meeting attendees. Minutes will be distributed to all MGSG members.

1.17. The Terms of Reference and membership of the MGSG will be reviewed annually.

Core Membership of the MGSG

1.18. The Chief Pharmacist/ Senior Operational Manager should chair the MGSG meetings on a rotational basis.

1.19. In addition to the chair and deputy chair, permanent membership will comprise of nominated operational/ clinical representatives from:

- community health
- Estates department
- AE (MGPS)
- Authorised Person (MGPS)
- dental services
- clinical skills
- hotel/ portering services
- health and safety
- Anaesthesiology
- finance representative
- any department nominated during formation of inaugural constitution

Other guidance

1.20. Guidance on provision of MGPS is also given in Scottish Health Planning Notes (SHPNs), Health Building Notes (HBNs) that are still applicable in Scotland and other relevant British, European and International standards.

2. Basic description of a MGPS

General

2.1. A Medical Gas Pipeline System (MGPS) 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. Various medical gas systems and pipeline installation elements are shown in Scottish Health Technical Memorandum (SHTM) 02-01 Part A.

2.3. Details of the quality requirements for medical gases are given in Section 13 of SHTM 02-01 Part A. These requirements are summarised as follows:

- medical gases supplied from cylinder or liquid sources should comply with the appropriate European Pharmacopoeia (Ph. Eur.) monograph
- medical air (MA), synthetic air plant and pressure swing adsorber (PSA) systems should comply with the appropriate Ph. Eur. monograph and the requirements given in Appendix K of SHTM 02-01 Part A

Sources of supply

Oxygen

2.4. For oxygen systems, the source of supply can be bulk liquid oxygen in a bulk liquid oxygen storage system, also known as a vacuum-insulated evaporator (VIE), liquid or gas cylinders, or an oxygen concentrator such as a PSA system. When gas 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.

2.5. A 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 mixture

2.6. Nitrous oxide and nitrous oxide/ oxygen mixture supply systems are usually supplied from a medical gas manifold system in two banks. Nitrous oxide cylinders contain liquid and gaseous product with a liquid/ gaseous boundary; they must be used upright.

Medical air

2.7. For MA systems used in respiratory applications, the source of supply can be:

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

2.8. Emergency reserve manifold systems are provided for all gases.

2.9. Air or nitrogen for surgical tools is required at 700 kPa. The air supply can be provided by:

- a medical gas cylinder manifold system
- a dedicated surgical compressed air plant or
- a compressed air plant supplying both medical air (MA) and surgical air (SA)

Medical vacuum

2.10. Second to oxygen, medical vacuum (MV) is the most prominent service from a medical gas perspective. Its use and availability is potentially the same as that of oxygen for preservation of life. How that vacuum is actually provided at the point of clinical use can vary and depending on the informed design process (IDP) can be delivered in many ways, other than from the traditional approach of having a centralised piped system. The primary aims of ‘net- zero’ in healthcare cannot be met unless the critical assessment of the actual requirements that are needed for safe clinical care are developed and shared during the IDP. The procedure for cleaning vacuum systems is given in Appendix D .

Distribution systems

2.11. Medical gases and vacuum may be distributed throughout the healthcare facility via the pipeline distribution system to provide the services 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 and the like. Medical supply units should comply with the relevant sections of British Standard (BS) European Standard (EN) Internation Standard (ISO) 11197.

2.12. 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

2.13. 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 ISO 7396-1 - Pipelines for compressed medical gases and vacuum

3.1. British Standard (BS) European Standard (EN) International Standard (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.

3.2. 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, ISO 10083
- extensions and modifications of existing pipeline systems

3.3. 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 (MGPS) supplying hyperbaric chambers

BS EN ISO 7396-2 - Anaesthetic gas scavenging disposal systems

3.4. BS EN ISO 7369-2 specifies the requirements for design, installation, function, performance, documentation, testing and commissioning of anaesthetic gas scavenging systems (AGSS) for anaesthetic gases and vapours.

3.5. Specific components are used for scavenging terminal units and for other connectors which are intended to be used by the operator. AGSS are tested and certified to operate at the required flows and without leakage.

BS EN ISO 7396-3 - Medical gas pipeline systems. Proportioning units for the production of synthetic medical air

3.6. This document specifies requirements relating to the construction and operation of devices producing air through the blending of oxygen and nitrogen for use as sources of supply in supply systems for medical gases.

3.7. It is applicable to proportioning units intended to produce synthetic medical air (MA) and air for driving surgical tools by mixing in defined proportions oxygen and nitrogen.

3.8. It is also applicable to proportioning units intended to be components of a medical gas supply system for MA which supplies a medical gas pipeline distribution system complying with BS EN ISO 7396-1.

BS EN ISO 9170-1 - Terminal units for medical gas pipeline systems - Terminal units for use with compressed medical gases and vacuum

3.9. This standard discusses terminal units for MGPS. It is intended specially to ensure the gas-specific assembly, mechanical resistance, flow, leakage, and pressure drop of terminal units to prevent their interchange between different gases and services.

3.10. It applies to terminal units intended for use in MGPS in accordance with BS EN ISO 7396-1, as pressure outlets on pressure regulators in accordance with BS EN ISO 10524-1, and as pressure outlets on pressure regulators integrated with cylinder valves (valve with an integral pressure regulator (VIPR)) in accordance with BS EN ISO 10524-3.

BS 5682 - Dimensions of probes and terminal units for medical gas supply systems - Requirements

3.11. This standard defines the dimensions and compatibility of probes and terminal units used in an MGPS. It ensures that each gas type—such as oxygen, nitrous oxide, MA and vacuum—has uniquely indexed connectors to prevent cross-connection. The standard includes detailed specifications for probe collars, terminal unit rings, and marking systems, including colour coding and symbols. It excludes gases like nitrogen (for tools), carbon dioxide, and 93% oxygen. The 2015 revision adds helium/oxygen mixture connectors and aligns with international standards for safety and interoperability in healthcare environments.

BS EN ISO 11197 - Medical supply units

3.12. 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 ISO 10524-1 - Pressure regulators for use with medical gases. Pressure regulators and pressure regulators with flow-metering devices

3.13. This standard specifies the design, construction, type testing, and marking requirements for pressure regulators intended for the administration of medical gases and their mixtures in the treatment, management, diagnostic evaluation and care of patients or for gases used for driving surgical tools.

3.14. Examples of gases include oxygen, MA and oxygen/ nitrous oxide mixtures.

BS EN ISO 10524-2 - Pressure regulators for use with medical gases. Manifold and line pressure regulators

3.15. This specifies requirements for manifold and line pressure regulators used in an MGPS. It outlines design, construction, testing, and marking criteria for these regulators. It covers regulators intended for connection to cylinders with specific filling pressures and those used in pipeline systems for various medical gases.

BS EN ISO 10524-3 - Pressure regulators for use with medical gases. Pressure regulators integrated with cylinder valves (VIPRs)

3.16. This document specifies design, type testing, and marking requirements for cylinder VIPRs.

BS EN ISO 10524-4 - Pressure regulators for use with medical gases. Low pressure regulators

3.17. This applies to low pressure regulators (maximum 1400 kPa) that are used in many different types of medical device.

BS EN ISO 14971 - Medical devices. Application of risk management to medical devices

3.18. This document outlines the principles and processes for risk management, especially during design, installation and use of gas systems and associated devices. It supports the risk-based approach advocated by Scottish Health Technical Memorandum (SHTM) 02-01.

BS EN ISO 5359 - Anaesthetic and respiratory equipment. Low-pressure hose assemblies for use with medical gases

3.19. This specifies requirements for low-pressure hose assemblies used with medical gases. These hoses are intended for use with various medical gases like oxygen, nitrous oxide, MA, helium, carbon dioxide, xenon, and specified mixtures. The standard also covers vacuum systems and hoses for driving surgical tools. It focuses on ensuring gas specificity and preventing cross-connection between different gas systems.

BS EN ISO 21969 - High pressure flexible connections for use with medical gases

3.20. 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.

BS EN ISO 15001 - Anaesthetic and respiratory equipment. Compatibility with oxygen

3.21. This standard specifies requirements for the oxygen compatibility of materials, components and devices for anaesthetic and respiratory applications, which can come into contact with oxygen in normal condition or in single fault condition at gas pressures greater than 50 kPa. It is applicable to anaesthetic and respiratory equipment connected to an MGPS such as pressure regulators, terminal units, medical supply units, flexible connections, flow-metering devices, anaesthetic workstations and lung ventilators.

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

3.22. This covers the design and manufacture of acetylene manifolds for welding, cutting and the like.

3.23. The standard is not retrospective, but all repairs or modifications to existing systems should meet the new standard's requirements wherever possible.

3.24. 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.

BS 1710 - Specification for identification of pipelines and services

3.25. This standard covers colour coding and labelling standards for medical gases.

Resistance to ignition

3.26. BS EN ISO 10524 includes requirements for resistance to ignition. For low pressure regulators (inlet pressure <3,000 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.

3.27. 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 10 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.

BS EN ISO 9001 - Quality management systems

3.28. BS EN ISO 9001 is the British and European adoption of the international standard ISO 9001, which sets out the criteria for a Quality Management System (QMS).

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

3.29. BS EN ISO 13485 is the British and European adoption of the international standard ISO 13485, which specifies requirements for a QMS tailored specifically to the medical device industry. It is designed to help organisations consistently meet regulatory and customer requirements for the safety and performance of medical devices.

Statutory obligations and other important documentation

3.30. Some of the more important documentation relating to medical gas systems is presented below. The websites of the governing bodies should be referred to for the latest version of a particular standard.

The Pressure Equipment (Safety) Regulations 2016

3.31. The Pressure Equipment (Safety) Regulations 2016 apply to pressure equipment and assemblies with a maximum allowable pressure above 0.5 bar. They apply to the design, manufacture and conformity assessment of this equipment. Assemblies of such equipment (that is, a pressure system) are also covered.

Pressure Equipment Regulations 1999

3.32. These regulations govern the design, manufacture, and conformity assessment of pressure equipment and assemblies with a maximum allowable pressure greater than 0.5 bar.

The Pressure Systems Safety Regulations 2000

3.33. 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 (Safety) Regulations 2016.

3.34. 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

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

3.36. The requirements contained within an HSE Approved CP 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) (CP (MGPS)) defined under the permit-to-work system in this SHTM)
- 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 shutdowns 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

3.37. 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.

3.38. 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.

3.39. 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.

3.40. Combinations of general ventilation, AGSS and other local exhaust ventilation (LEV) systems may be required to ensure compliance with COSHH.

3.41. Anaesthetic agents were assigned occupational exposure standards (OESs) by the HSE. These are listed below:

Table 3.1 - Anaesthetic agent OESs

Anaesthetic agent	OES over an 8-hour Time-weighted average (TWA) reference period
Nitrous oxide	100 parts per million (ppm)
Enflurane	50ppm
Isoflurane	50ppm

Note 3: The current international standard for AGSS is BS EN ISO 7396-2. This standard recognises the great reduction in overall and fresh gas flows that have resulted from changes in clinical practice, and hence the reduction in the flow rates to control this. These low-flow anaesthetic procedures have continually developed and in some instances have reduced the TWA occupational exposure limit (OEL) below control levels without the requirement for an AGSS. The theme of this work is continuing and currently being evaluated by the National Green Theatre Programme in Scotland. BS EN ISO 7396-2 is the system specification that should be utilised as the basis for an informed design process (IDP) for the AGSS standard under current regulatory requirements.

Legal requirement

3.42. 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.

3.43. Staff should be reminded of the need to reduce leaks from the MGPS and anaesthetic equipment to a minimum.

3.44. Other guidance applies:

- the HSE's (2002) 'EH40/2005 - Workplace Exposure Limits'
- the HSE's (1996) 'Anaesthetic agents: controlling exposure under COSHH'

Management of Health and Safety at Work Regulations 1999

3.45. These Regulations necessitate formal risk assessment by employers in relation to the health and safety of their employees and others, arising from work activities.

Workplace (Health, Safety and Welfare) Regulations 1992

3.46. 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

3.47. 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

3.48. These Regulations (as amended by the Health and Safety (Miscellaneous Amendments) Regulations 2002) cover the handling and transportation of medical gas cylinders.

3.49. A risk assessment should be performed for all situations. Manual handling training is essential for all staff handling medical gas cylinders.

3.50. 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

3.51. 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 (MV) 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

3.52. 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

3.53. 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.

The Medicines Act 1968

3.54. 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.

3.55. The Responsible Pharmacist is responsible for quality control of medical gases.

3.56. Medical gas 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

3.57. The arrangements and procedures for the reporting of adverse incidents, the dissemination of safety advice and the control of risks relating to health, social care, estates and facilities equipment are detailed within the Chief Executives Letter (CEL) - CEL 43 (2009) issued by the Scottish Government. The purpose of the Letter is to remind healthcare organisations as to the importance of prompt reporting of equipment defects and failures to the Incident Reporting and Investigation Centre (IRIC) and of the procedures to follow when such failures occur. All staff working in a healthcare environment have a responsibility to comply with the reporting arrangements, including those contractors and private or independent service providers who provide estates/ facilities services.

3.58. This CEL provides guidance on:

- adverse incident/ user reporting system in Scotland
- the role of NHS Scotland Assure IRIC
- reporting arrangements
- actions required and responsibilities
- what defects and failures are reportable
- applicable estates and facilities equipment
- management of defective/ failed items

3.59. Further information is available by accessing the National Services Scotland (NSS) website at Report an Incident.

4. Functional responsibilities

General

4.1. This chapter describes the roles and responsibilities of key personnel involved in the operation, maintenance and use of medical gas pipeline systems (MGPS). The job titles given are generic and 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 (FM) organisation or a 'Non-profit distributing'/ 'Public Private Partnership' 'Private Finance Initiative' NPD/ PPP/ PFI consortium). This structure follows the requirements as set out in British Standard (BS) European Standard (EN) International Standard (ISO) 7396-1, Annex G.

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) (AP (MGPS)).

4.4. There may be times when an AP (MGPS) is unavailable to manage the MGPS. In such circumstances it is essential that adequate AP (MGPS) cover is provided to enable the MGPS to function effectively at all times.

4.5. This Scottish Health Technical Memorandum (SHTM) recommends that the AP (MGPS) should have the responsibility for ensuring that the MGPS is operated safely and efficiently.

4.6. An AP (MGPS) in liaison with the Quality Controller (MGPS) (QC (MGPS)) will decide whether an MGPS should be taken into or out of use.

Management and competency

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 facilities managed premises, the NPD/ PPP/ PFI consortium FM provider may directly employ estates staff. However, the FM provider by appointment of an AP (MGPS) will retain the responsibility of the day-to-day management of all medical gas and vacuum sources of supply and distribution systems in accordance with the guidelines laid down by this code of practice (CP).

4.8. Competency is defined as the application of skills, knowledge, experience and behaviours consistently to achieve a specific outcome.

4.9. The correct management of medical gases is a key function of a healthcare organisation and all those involved must be competent and be able to perform their required duties in a suitable and sufficient manner. The technically designated roles now have a recognised National Occupational Standard (NOS) (see Section 7) and it is a requirement for persons in these roles to be suitably trained and assessed and to maintain their level of competency through Continuing Professional Development (CPD).

4.10. The person with overall responsibility for medical gases must ensure that all roles (including their own) are managed correctly and that the roles and responsibilities are understood and can be delivered in a satisfactory manner to provide assurance to the healthcare organisation.

4.11. It is recommended that the appointment process and letter of appointment recognises competence and that the designated person is capable of fulfilling their role. If any training needs are identified, then a plan should be in place to facilitate this. An appointment letter should be agreed with the applicant and have a suitable form of words such as:

"I [ ] have read and understand the roles and responsibilities for the position I need to perform, and feel I have the relevant knowledge, skills and resources to discharge my function in a suitable and sufficient manner"

or if additional training is identified:

"I [ ] have read and understand the roles and responsibilities for the position I need to perform, I feel I need assistance in [ ] to fully discharge this role and will accept training to remedy this situation by (date). Until this time I will mitigate this by utilising additional resources (state what these mitigations will be) to discharge my responsibilities"

Key personnel

4.12. The following are the key personnel who have specific responsibilities within the MGPS operational policy:

- Executive Manager
- Senior Operational Manager
- Authorising Engineer (MGPS) (AE (MGPS))
- Authorised Person (MGPS) (AP (MGPS))
- Competent Person (MGPS) (CP (MGPS))
- Quality Controller (MGPS) (QC (MGPS))
- Designated Clinical Officer (MGPS) (DCO (MGPS))
- Staff - cylinder management

Executive Manager

4.13. The Executive Manager is defined as the person with ultimate accountability and management responsibility, including the allocation of resources and the appointment of personnel, for the organisation in which the MGPS are installed.

4.14. Depending on the nature of the organisation, this role may be filled by the General Manager, Chief Executive, or other person of similar authority.

4.15. The formal responsibility for the MGPS rests with the Executive Manager, although the AP (MGPS) retains effective responsibility for day-to-day management of the MGPS.

4.16. The Executive Manager is responsible for the implementation of an operational policy for the MGPS. They 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.

4.17. 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.

4.18. In most healthcare organisations, the Medical Gas Safety Group (MGSG) will take responsibility for the preparation, implementation and monitoring of the MGPS operational policy, and will involve senior medical and nursing personnel.

Senior Operational Manager

4.19. The Senior Operational Manager holds responsibility for the integrity of the MGPS. In a typical healthcare organisation employing direct labour, there may be one or more AP and CP (MGPS) with clear line management responsibility.

4.20. In situations where the AP (MGPS) and CP (MGPS) are contracted to the healthcare organisation or are employed by the NPD/ PPP/ PFI consortium FM provider, it will be necessary to identify a function within the organisation that is analogous to the Estates management function within the healthcare organisation. Within this function, senior management will appoint AP and CP (MGPS): the former on the recommendation of an independent Authorising Engineer (MGPS) (AE (MGPS)) and the latter following assessment by the AP (MGPS) within the organisation.

4.21. The Senior Operational Manager should also monitor the implementation of the MGPS operational policy. In particular, the MGPS should comply with the requirements of this SHTM, and all work should be carried out in accordance, where possible, with the permit-to-work procedures.

4.22. The Senior Operational Manager in collaboration with the AP (MGPS) is responsible for ensuring that work is carried out only by approved specialist contractors registered to BS EN ISO 9001 and BS EN ISO 13485, 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.

Authorising Engineer (MGPS)

4.23. The AE (MGPS) should be suitably qualified in accordance with the requirements of Section 7 of this SHTM.

4.24. This person, as the technical professional adviser to the healthcare organisation, will have specialist knowledge of MGPS, contractual management, design, validation of design and systems, procurement procedures, statutory and legislative requirements, specification, and be conversant with the relevant codes of practice, being employed independently of external organisations submitting potential AP (MGPS) for assessment.

4.25. The AE (MGPS) will, subsequent to performing an assessment of a potential AP (MGPS), recommend to the Executive Manager of the healthcare organisation either that the person is able to proceed to written appointment or requires further training.

Authorised Person (MGPS)

4.26. The AP (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 AP (MGPS) in respect of the permit-to-work procedure are set out in paragraph 6.91. The AP (MGPS) also has specific duties with regard to bulk liquid oxygen installations (see Appendix E). In situations where the AP (MGPS) is employed by the NPD/ PFI/ PPP FM provider, the AP (MGPS) must assume all roles and responsibilities associated with this role including the day-to-day management of all sources of supply.

4.27. All AP (MGPS) should be appointed in writing by the Executive Manager on the recommendation of an AE (MGPS). An individual assessment of the suitability of the potential AP (MGPS) will be required before such a recommendation can be made.

4.28. Procedures using permits for the authorisation of work require the fullest cooperation of all staff, and their acceptance of the responsibilities involved. The AP (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.

4.29. The AP (MGPS) is responsible for ensuring that:

- all DCO (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
- all terminal units affected, that is, out of service, are appropriately labelled with 'danger do not use' notices

4.30. Arrangements should be made to ensure that cover for an AP (MGPS) is always available, particularly during holidays and other absences.

4.31. The AP (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. They should have direct contact with the QC (MGPS), users and other key personnel.

4.32. The AP (MGPS) is responsible for assessing the competency of all CP (MGPS) employed directly by the estates/ operations department and for maintaining a list of CP (MGPS).

4.33. The MGSG should be consulted before the purchase of any medical equipment that will be connected to the MGPS.

Appointment of Authorised Persons (MGPS)

4.34. All AP (MGPS) will be appointed on the recommendation of an AE (MGPS).

4.35. This AP (MGPS) may be appointed from within:

- the directly employed workforce of the healthcare organisation with overall responsibility for the healthcare establishment
- a neighbouring healthcare organisation
- the NPD/ PPP/ PFI FM contractor
- a specialist MGPS contractor working as a subcontractor to the NPD/ PPP/ PFI FM organisation
- a specialist agency offering AP (MGPS) services

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

4.37. This arrangement can also be used on NPD/ PPP/ PFI FM sites where the NPD/ PPP/ PFI FM contractor has no directly employed AP (MGPS). However, if none of the healthcare

organisation's properties employs an AP (MGPS), it will be necessary to contract in an AP (MGPS) from one of the latter two options listed in paragraph 4.35.

4.38. For healthcare organisations with only a single site, the AP (MGPS) may be employed by the healthcare organisation as a member of the estates staff, or as detailed in paragraph 4.35. Notwithstanding the procurement route, the FM provider will be responsible for the day-to-day management and maintenance of the MGPS consisting of the sources of supply, fixed and flexible pipework, valves, trunking, bedside panels, pendants, terminal units and warning systems irrespective of user purchase or rental.

4.39. Establishments with no directly employed AP (MGPS) and no NPD/ PPP/ PFI FM contractor involvement (for example some community and hospice sites) will prove the most difficult in terms of MGPS management, because - should an AP (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 AP (MGPS) at the earliest opportunity.

> Note 4: Although it may be possible for the contractor's CP (MGPS) (CP(MGPS)) to effect repairs within a relatively short period (for example two hours), it may not be possible for an AP (MGPS) to attend the site during this period. In these circumstances it will be necessary for a member of the (community site or hospice) staff to sign the permit to allow work to continue.

4.40. 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.

4.41. Potential providers of AP (MGPS) services are reminded that:

- AP (MGPS) appointments cannot be made unless recommended by an AE (MGPS)
- this registration will require proof of familiarity with the area(s) of responsibility of the AP (MGPS)
- appropriate professional and public liability insurance must be carried

Coordinating Authorised Person (MGPS)

4.42. On a large site, there could be several AP (MGPS). In this case, the Executive Manager should appoint one as the Coordinating Authorised Person (MGPS) with overall responsibility for the site upon the recommendation of the AE (MGPS).

4.43. The Coordinating Authorised Person (MGPS) will coordinate the actions of all other AP (MGPS) within their area of responsibility and will manage the permit-to-work system and other MGPS safety aspects in that area.

Competent Person (MGPS)

4.44. The CP (MGPS) is the person who carries out installation and/ or maintenance work on the MGPS. A list of their responsibilities and duties is set out in paragraph 6.92. The CP (MGPS) should have received appropriate training and should be on a list of CP (MGPS). In the case of directly employed labour, this list should be held by the AP (MGPS); in the case of contracted labour, it should be held by the contractor's AP (MGPS) or project manager.

Assessment of competency of the Competent Person (MGPS)

4.45. The CP (MGPS) may be a member of a specialist contractor's staff or of the healthcare organisation's Estates department.

4.46. CP (MGPS) must be able to demonstrate knowledge, skills, experience and behaviours in MGPS maintenance and/ or installation.

4.47. Where the CP (MGPS) is a member of the healthcare organisation's Estates department, the AP (MGPS) is responsible for assessing the competency of the CP (MGPS) with respect to work on the MGPS.

4.48. Where CP (MGPS) are members of a contractor's staff, the contractor is responsible for assessing the competence of those staff and maintaining a register of CP (MGPS).

Quality Controller (MGPS)

4.49. The QC (MGPS) is the person designated as the quality controller for MGPS. They are responsible for the quality control of the medical gases at the terminal units and plant such as medical air (MA) compressors, oxygen concentrators and synthetic air systems.

4.50. The QC (MGPS) will accept the professional responsibility for the last independent check of the purity of the gases of the MGPS services that, if faulty, could cause critical clinical consequences to patients.

4.51. The AP (MGPS) should contact the QC (MGPS) when testing of the MGPS is required. AP (MGPS) contracting in QC (MGPS) services should ensure that documentary evidence of continuing and recent experience in MGPS testing is provided before a contract is finalised.

4.52. The AP (MGPS) will need to liaise with the QC (MGPS) before an MGPS can be taken into use, as quality tests will be required before gases are passed to patients; the specific tests and requirements are set out in Section 13 and Appendix K, SHTM 02-01 Part A.

4.53. Guidance on appointing QC (MGPS) to carry out quality-control testing of MGPS is given in Section 7. This section also contains guidance on eligibility for registration on the QC (MGPS) register maintained by the NHS Pharmaceutical Quality Assurance Committee.

Designated Clinical Officer (MGPS)

4.54. The DCO (MGPS) is the person in each department with whom the AP (MGPS) liaises on any matters affecting the MGPS and who would give permission for a planned interruption to the supply.

4.55. It is essential that there is liaison between the medical and nursing staff that use the MGPS and the AP (MGPS) to ensure that the MGPS is appropriate to their needs.

4.56. The DCO (MGPS) should give permission for any interruption to the MGPS and should sign the appropriate parts of the permit-to-work.

4.57. The MGPS operational policy should clearly set out the requirements for such permission, including the circumstances dictating signature by the DCO (MGPS).

4.58. The DCO (MGPS) is responsible for ensuring that all clinical/ nursing staff are aware of the interruption to the MGPS and which terminal units cannot be used.

4.59. There should ideally be a DCO (MGPS) for every department; the MGPS operational policy should list the DCO (MGPS) and the arrangements for cover due to absences of the DCO (MGPS).

4.60. The DCO (MGPS) acts as the focal point for communications related to the MGPS and advises on any special requirements for their department relating to MGPS, such as provision of emergency cylinders and vacuum pumps.

4.61. The DCO (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.

4.62. All DCO (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.

4.63. The MGPS operational policy should set out the training requirements as defined in Section 7.

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. Existing installations should be assessed for compliance with this guidance document based on risk in accordance with British Standard (BS) European Standard (EN) International Standard (ISO) 14971 and the informed design process (IDP) risk assessment. The standard of safety should be to the same level that is given in this document.

5.3. Each risk is then attributed a priority level, and high-priority risks are summarised and used to develop a remedial action plan. A plan for upgrading existing systems should be prepared if required, taking account of the priority for patient safety.

5.4. The operational policy will be based on the system at the time of the assessment, 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 medical gas pipeline systems (MGPS).

5.5. 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

5.6. The Executive Manager is responsible for the operational policy, although responsibility for policy preparation and implementation will be undertaken by the Medical Gas Safety Group (MGSG), comprising, as a minimum, the Authorising Engineer (MGPS) (AE (MGPS)), the Authorised Person (MGPS) (AP (MGPS)), Pharmacy, the Quality Controller (MGPS) (QC (MGPS)), representatives from clinical and nursing specialties, health and safety and medical physics. Other members can be co-opted as necessary.

5.7. Such a group should review the policy at least annually, but a procedure for immediate updating of, for example, contact details must operate regardless of the meeting frequency. Usually, the Senior Operational Manager chairs the meetings and reports the minutes to the group membership and the Executive Manager.

5.8. Separate policies or procedures are sometimes prepared to supplement the operational policy. It is acknowledged that some healthcare organisations 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).

5.9. 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.

5.10. 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 Estates/ Operations Manager. The details of such delegation should be set out in the operational policy.

Operational considerations

System limitations

5.11. 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 (MA) system supplied from a cylinder manifold system is unlikely to sustain the use of respiratory ventilators.

5.12. 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.

5.13. Where pressure swing adsorber (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.

5.14. 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.

5.15. Staff must be advised not to use medical gases for non-medical purposes other than as a test gas for medical equipment.

5.16. MA 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 an oxygen or MA system.

System hazards

5.17. 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.

5.18. Users of 700 kPa surgical air (SA) 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

5.19. The operational policy should set out the procedures to be followed in the event of an emergency. This should include the following:

- reporting an incident
- action to be taken (for example turning off isolation valves, use of portable emergency cylinders)
- liaison with other staff and departments
- calling out contractors

5.20. 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.

5.21. 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 AP (MGPS) in particular should take a lead in explaining to users the function of the system, and they will have to be adequately trained and informed about the system (see Section 7).

5.22. They should be similarly familiar with the purpose of area valve service units (AVSU) and how to use them in an emergency.

5.23. 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 standby conditions are as selected.

Medical equipment

5.24. The MGPS operational policy is not intended to be applied to the use, maintenance and the like of patient-connected equipment except when the use of such equipment may influence the operation of the MGPS.

5.25. The MGSG should be consulted before the purchase of any medical equipment that will be connected to the pipeline.

5.26. Certain ventilators can also have a significant effect on the capacity of oxygen systems, particularly those operating under CPAP.

5.27. 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 Section 10
- some older types of blending equipment can allow backflow from one pipeline to another, leading to, for example, oxygen enrichment of MA systems or reduction of oxygen content in oxygen pipelines. When not in use, blenders should be disconnected

Note 5: BS ISO 11195 'Gas mixers for medical use. Stand-alone gas mixers were developed to avoid this problem.

- portable suction units should be used in infectious diseases units where there is a possibility that the vacuum system could become contaminated. The need should be determined in discussion and with the guidance of the Infection Control Officer

5.28. 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.

5.29. In some accommodation, for example labour, delivery, recovery, postpartum (LDRP) rooms, 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

5.30. Medical gases supplied from cylinder or liquid sources should comply with the European Pharmacopoeia (Ph. Eur). PSA systems should accord with the recommendations given in Section 5, Part A. All other gases or medical gas mixtures should comply with the product licence specification held by the gas supplier.

5.31. 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 a central plant alarm panel(s) within the pharmacy department.

5.32. 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

5.33. Any work involving alterations, extensions or maintenance work on the system should be subject to the permit-to-work procedure set out in Section 6, which should be under the control of the AP (MGPS).

Responsibility for gas cylinders

5.34. 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 Section 8 should be followed.

Record drawings

5.35. The Estates department should have accurate and up-to-date drawings and building information modelling (BIM) of the MGPS showing main sections and branches, departments served, isolating valves, terminal units and alarm systems for each medical gas service.

5.36. These drawings should be readily available on site for use by the AP (MGPS), and all AP (MGPS) should know their location.

5.37. 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 also indicate the type and make of terminal units.

5.38. A schematic diagram of the installation should be provided.

5.39. When additions or alterations are to be made to existing installations by a contractor, the AP (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 AP (MGPS) at least one copy of an amended print, indicating pipework alterations and the like. The AP (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 then to replace the original master drawing.

Note 6: Up-to-date drawings and records are required under the Pressure Systems Safety Regulations 2000.

Locking of valves and plantrooms for MGPS

5.40. 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.

5.41. 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.

5.42. Medical gas plantrooms should be kept locked, except when work is in progress in them.

5.43. Plantrooms containing medical gas cylinders should be kept locked, with a prominently displayed notice indicating the location of the spare key.

5.44. For access to plantrooms, see Section 12 of Scottish Health Technical Memorandum (SHTM) 02-01, Part A.

5.45. The valves forming part of the liquid oxygen installation within the compound need not be kept lockable. The gate to the liquid oxygen installation should be kept locked by a combination lock, the number of which should be made known to the fire brigade.

5.46. The procedure for keeping keys, described in the MGPS operational policy, should be followed.

Contractors

5.47. All contractors should comply with the healthcare organisation or building safety policy. This should be clearly stated in the operational policy.

5.48. 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.

5.49. The operational policy should set out the responsibilities for monitoring the work of contractors. This would normally be coordinated by the AP (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

General

6.1. Safety rules and procedures for medical gas pipeline systems (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 Control of Substances Hazardous to Health (COSHH) Regulations 2002.

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 the responsibility of the healthcare facility, this is commonly discharged to the estates department but can also be provided through a contractual arrangement. The Authorised Person (MGPS) (AP (MGPS)) has day-to-day responsibility for the MGPS and is responsible for the implementation of the permit-to-work system. On sites where several AP (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 healthcare premises, and any planned actions, such as the closure of an isolating valve, which restricts the supply. A permit-to-work is not required to operate valves in the event of an emergency, for example a confirmed fire.

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 Figure 6.1 and Figure 6.2 overleaf.

Figure 6.1 - High hazard permit to work

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_2O	O_2/N_2O	MA	SA/SN_2	VAC	AGSS	He/O_2	CO_2

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 during this work: Type _____ No _____

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 ands 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_2O	N_2O/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.

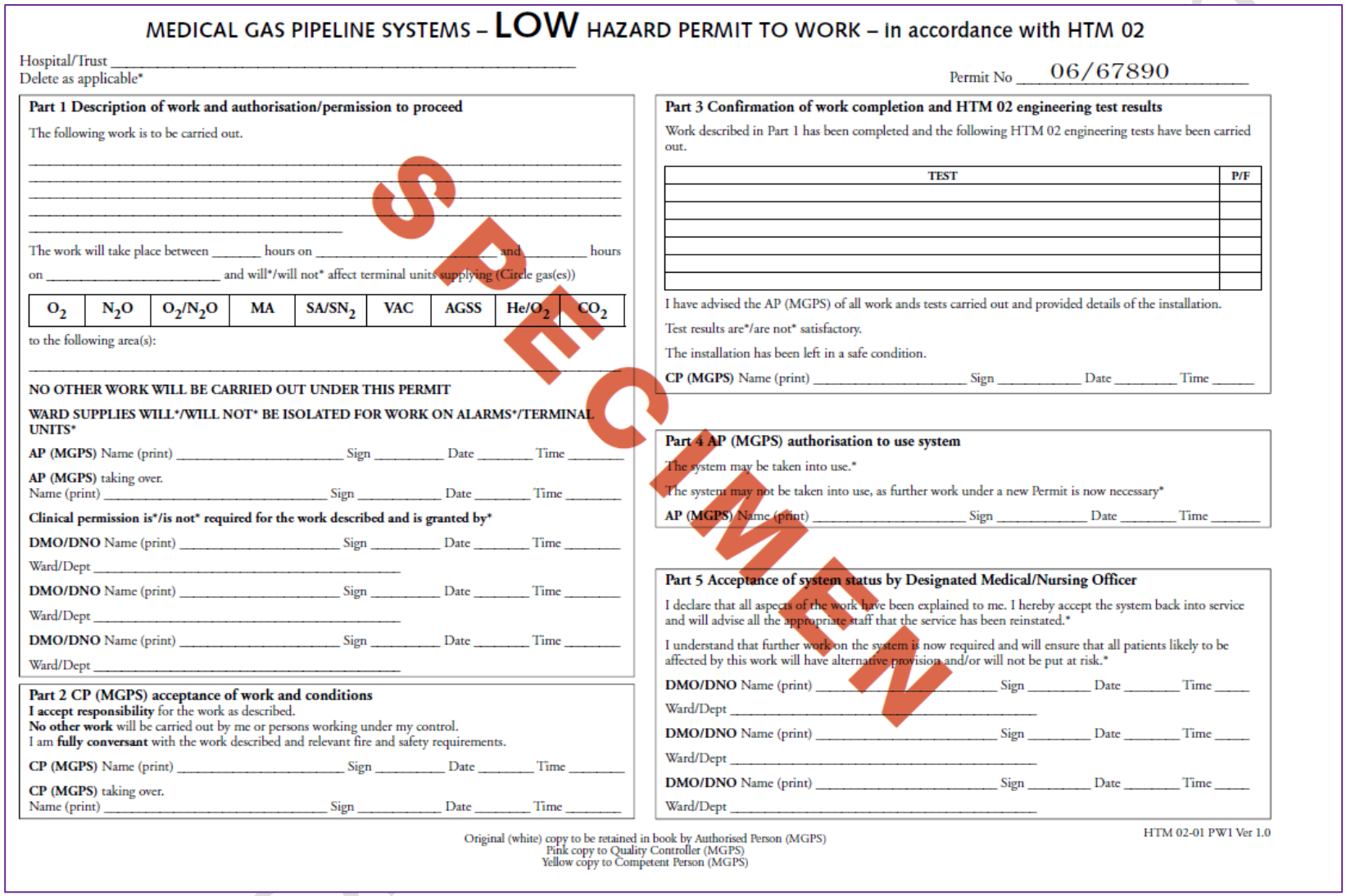
DMO/DNO Name (print) _____ Sign _____ Date _____ Time _____

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 6.2 - Low hazard permit to work



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_2O	O_2/N_2O	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 ands 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

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:

- copy 1 (white, top copy - permanent) remains in the permit book and carries all original signatures (it is to be retained by the AP (MGPS) on completion of the work)

Note 7: For legal purposes, this copy bears all original signatures. It should be completed in black indelible ink.

- copy 2 (pink - tear-out) is given to the Quality Controller (MGPS) (QC (MGPS)) on completion of the work
- copy 3 (yellow - tear-out) is given to the Competent Person (MGPS) (CP (MGPS)) (it may be returned to the AP (MGPS) on completion of the work if not needed by the CP (MGPS)
- copy 4 (green) - only with high hazard permits: Isolation Diagram to sketch the point of isolation

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

Coding system for recording system tests

6.13. 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). The coding system should be attached to the permit book front cover for reference.

Electronic format

6.14. These forms are included in proprietary systems. These should comprise as a minimum of:

- an independently verifiable time and date stamp
- 'real time' configuration of data input
- the requirement for fields to be completed sequentially with relevant numerical or data values
- ability for digital signatures/ identification
- ability to issue 'read-only' copies of permits to recipients
- ability to provide digital records for audit trail

Note 8: 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 AP (MGPS) must discuss the content of this fourth sheet with the CP (MGPS) before the work begins, and a copy must be taken to the site of isolation, where it should be consulted by both the AP (MGPS) and the CP (MGPS) before isolation takes place.

Isolation of plant and pipeline system

6.15. The AP (MGPS) is responsible for witnessing the isolation of valves/ area valve service unit (AVSU)/ line valve assembly (LVA) 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.

6.16. 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 British Standard (BS) 5682 type terminal units, or the ward AVSU when servicing non-BS/ European Standard (EN) terminal units).

6.17. 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 blanking spade on the side of the system being worked on. 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

6.18. 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 AP (MGPS) as soon as possible, as remedial work will require the issue of a permit.

6.19. 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 QC (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

6.20. Permits are not necessary for the routine replacement of medical gas 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 healthcare staff responsible for cylinder replacement receive appropriate training in these techniques.

Commissioning of a new MGPS

6.21. 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 AP (MGPS) and QC (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

6.22. Permits are not required for the routine quality control tests of medical and surgical air (SA) provided by compressed air plant. 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 QC (MGPS)) other points in the system. The results of these tests should be retained by both QC (MGPS) and AP (MGPS). Unsatisfactory results may warrant shutdown of plant and remedial repairs. These should be covered by issue of a permit. The AP (MGPS)

should liaise with the QC (MGPS) on the extent of QC testing that will be required after major work on a medical or SA plant.

Permit-issuing authority and control of permits

6.23. The permit-issuing authority should be an AP (MGPS). On a large site where several AP (MGPS) operate, the Co-ordinating 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.

6.24. In exceptional circumstances, the following may sign a permit:

- an Authorising Engineer (MGPS) (AE (MGPS) in the absence of an AP (MGPS). However, the AE must be familiar with the system for which the permit is to be issued
- on a small site (for example a hospice) where no AP (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)

6.25. 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.

6.26. 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

6.27. Permits should only be issued to CP (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 AP (MGPS) and Designated Clinical Officers (MGPS) (DCO (MGPS)), as this is essential to ensure effective management of the work.

Life of permit (active and completed copies)

6.28. The permit should remain in force until the work is completed, the permit fully signed and the MGPS taken back into use.

6.29. For work lasting many weeks (for example isolation of a ward/ department for refurbishment), the AP (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.

6.30. All original copies of the permit (and any accompanying safety method statements, special instructions, other relevant permits and the like) should be retained by the AP (MGPS) in a file dedicated to MGPS documentation.

6.31. Completed permits should be kept for the life of the MGPS.

Receiving authority

6.32. Permits should only be issued to CP (MGPS), who are to be engaged in work on the MGPS.

6.33. If an AP (MGPS) performs the work described on the permit, they will have to sign as the CP (MGPS) on the relevant parts of the permit.

Responsibility for work

6.34. A CP (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 AP (MGPS) and relevant testing procedures on completion.

6.35. The CP (MGPS) should be fully conversant with its terms and requirements and should give sufficient and clear instructions to staff working under their supervision.

6.36. Contracts should be only placed with firms who are appropriately registered as described in paragraph 5.48. Further guidance on contractors' competence and the like is given in Section 10.

6.37. The CP (MGPS) should endeavour not to leave the work site during the lifetime of the permit. However, if for example the work is halted between shifts, the CP (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 CP (MGPS) (for example during a further shift), this CP (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), for high hazard permit applications.

Limits of authorisation

6.38. 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 safely. The fourth sheet (green copy) of the high hazard permit will provide an illustration of the isolation to be carried out.

6.39. 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 once the permit has been issued.

Cancellation of permits before completion of work

6.40. 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 CP (MGPS) must return the yellow copy of the permit to the AP (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).

6.41. The cancelled permit should be accompanied by a written statement from the AP (MGPS) describing the stage at which the work was stopped and the reason why.

6.42. The CP (MGPS) and AP (MGPS) must ensure that the system is left in a safe condition.

6.43. If there is to be a delay before issue of another permit and resumption of work, the CP (MGPS) must remove all tools and equipment and leave the site in a safe condition.

6.44. The AP (MGPS) must notify the (DCO (MGPS)) of the situation and arrange alternative supplies if necessary.

6.45. 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

6.46. If the yellow copy of the permit is lost by the CP (MGPS), the AP (MGPS) must be informed so that the loss can be recorded on the white, pink and, where appropriate, green copies in the permit book.

6.47. The CP (MGPS) must countersign and date these copies.

6.48. 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 QC (MGPS) will be given the pink copy, when it has been fully signed, along with copies of any appropriate documentation.

Typographical errors

6.49. These should be crossed through, corrected and initialled by the AP (MGPS).

Maintaining contact with the Authorised Person (MGPS)

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

Permission for work to take place

6.51. Work on an MGPS that will lead to interruption of supplies will require signing of the permit by a DCO (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.

6.52. The MGPS operational policy will also define the extent of responsibility of DCO (MGPS) when signing MGPS permits. For example, a DCO (MGPS) may be given responsibility for a whole hospital, multiple wards or just a single ward. DCO (MGPS) are often involved if the gas supply to a whole department is to be shut down. 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

6.53. There should be general agreement between the AP (MGPS) and the DCO (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.

6.54. The AP (MGPS) should describe to the DCO (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 AP (MGPS) should also explain that a signature of a DCO (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

6.55. The AP (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 healthcare/ pharmacy/ medical engineering departments may be necessary.

Essential liaison with the Quality Controller (MGPS)

6.56. It is essential that the QC (MGPS) be informed well in advance of work that will involve quality and/ or identity testing.

6.57. The extent of the work and any potential problems should be discussed so that the QC (MGPS) may determine the likely staffing/ time requirements of the task.

6.58. The AP (MGPS) should make available all necessary pipelines and as-fitted drawings, and state which gases are involved to allow the QC (MGPS) to select appropriate test equipment.

6.59. The AP (MGPS) must arrange for the QC (MGPS) to have access to the system when testing is required, as delays will be inevitable if this cannot be provided.

6.60. The AP (MGPS) should ensure that all necessary engineering tests have been completed with satisfactory results before QC testing takes place.

6.61. If the testing is to be carried out by a QC (MGPS) who is not employed on site (for example a contracted-in QC (MGPS) from another healthcare facility within the healthcare organisation 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.

6.62. If testing is carried out by a specialist MGPS testing organisation, the AP (MGPS) and local QC (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 QC (MGPS) and the AP (MGPS) following the validation and verification process.

Accompanying documents

6.63. 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

Levels of hazard

6.64. Whenever work is to be carried out on the MGPS, it is assigned a level of hazard depending on the nature of the work.

6.65. It is important to appreciate that the hazard level relates to risks to the patient, not to the system maintainer or operative.

6.66. The AP (MGPS) assesses the hazard level at the time of preparing the permit and, if in doubt, will assess the hazard at the higher level.

6.67. Two levels of hazard are defined in paragraphs 6.68 - 6.88.

High hazard work

6.68. 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.

6.69. High hazard work will require subsequent tests for gas quality and/ or identity and performance of fittings and the like (including the ability to deliver the designed gas flow).

6.70. 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.

6.71. 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 specifications) and the moving of pendants containing flexible hoses fitted with mechanical connectors (non-interchangeable screw thread (NISTs)).

6.72. 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 Section 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 QC (MGPS).

6.73. 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.

6.74. 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).

6.75. In all such cases, it is essential that procedures are agreed with the QC (MGPS) and are documented in the MGPS operational policy.

6.76. 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.

6.77. By agreement with the QC (MGPS), emergency repairs using mechanical connectors specified in Section 12, 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.

6.78. Complete isolation of a vacuum system is classified as high hazard work and will require provision of portable vacuum pumps and/ or ejector-type vacuum units.

Low hazard work

6.79. This applies to all work on the MGPS that does not give rise to a high hazard situation.

6.80. 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.

6.81. 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).

6.82. Terminal units that comply with BS 5682 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.

6.83. Terminal units complying with BS 5682 include an automatic isolating valve. Some earlier terminal units include a manual isolating valve.

6.84. 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.

6.85. Terminal unit termination blocks should not be left unattended with the socket removed, unless a blocking plate has been attached.

6.86. 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 QC (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 QC (MGPS).

6.87. 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.

6.88. 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

6.89. The responsibilities of the AP (MGPS) are as follows:

- obtaining written permission (where appropriate) from DCO (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 CP (MGPS)
- supplying drawings of existing sections of the installation (as-fitted drawings)
- supervising isolation of the section on which work is to be carried out
- witnessing, supervising of tests of completed work as appropriate
- supervising purging with working gas(es)
- assisting the QC (MGPS) in final quality and/ or identity testing, in the case of high hazard work
- witnessing or supervising results of final performance tests of completed work in the case of low hazard work
- supervising or making the final connection of any extension
- restoring the gas service(s) by operation of appropriate valves/ AVSUs/ LVAs
- notifying the DCO (MGPS) of completion of work and removal of ‘do not use’ notices
- obtaining corrected copy of drawings
- supervising amendments of office copy of as-fitted drawings
- retaining original copy of permit and all permit books

- obtaining the DCO (MGPS)'s signature on the permit, accepting the system as fit for service

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

6.90. The responsibilities of the CP (MGPS) are as follows:

- obtaining and understanding instructions on work to be done
- signing the permit, acknowledging responsibility for the work
- isolating sections of the system on which work is to be carried out (under direct supervision of the AP (MGPS)
- carrying out the work
- carrying out system integrity tests on completed work (under direct supervision of the AP (MGPS) where appropriate)
- signing the permit, declaring that the work is completed as indicated. Copy 3 (yellow copy) of the permit must be returned to the AP (MGPS) and placed in the permit book for final signing
- 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 Clinical Officers (MGPS)

6.91. The responsibilities of the DCO (MGPS) are as follows:

- 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 6.51)
- advising other clinical/ nursing staff that the system is not available for use and any interim measures implemented
- on completion of the work, signing the permit and accepting the system back into use
- advising clinical colleagues and departmental heads that the system is/ is not available and fit/ unfit for use

Responsibilities of the Quality Controller (MGPS)

6.92. The QC (MGPS) is involved in testing after high hazard work and other work at their discretion. The responsibilities of the QC (MGPS) are as follows:

- identifying the test equipment required, depending on the specific service that has been disrupted (this equipment should be maintained and calibrated to accredited standards)

- carrying out final quality and/ or identity tests on the systems witnessed by the AP (MGPS)
- signing the permit, declaring that the pharmaceutical testing is completed by submission of the test results to the AP (MGPS)

The permit form

6.93. 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 AP (MGPS), CP (MGPS), DCO (MGPS) and the QC (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

6.94. In some instances (for example changing oil/ filters on plant), there will be no interruption to supplies and no DCO (MGPS) signature will be required. In other instances, although the work is of a low hazard nature, a DCO (MGPS) signature must be obtained, as entry to patient areas and interruption of gas supplies will be required (for example servicing of terminal units).

6.95. Both forms are described in paragraphs 6.96- 6.140 along with relevant comments on completion.

High hazard permit

6.96. The space on the top left of the form allows for entry of the hospital/ healthcare organisation name.

Part 1

6.97. This contains information on the work to be done, permission from a DCO (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 6.99).

6.98. 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.

6.99. 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 and the like), signed and dated by the AP (MGPS), should also be attached.

6.100. The QC (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 DCO (MGPS).

6.101. Safe isolation is essential; the AP (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 and the like to be isolated
- gas to be isolated

6.102. The AP (MGPS) signs and date's part 1 at the time of discussion with the DCO (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.

6.103. The QC (MGPS) should also be informed that high hazard work is to take place and that their attendance will be required for testing purposes.

6.104. The AP (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)

6.105. This is for the CP (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 CP (MGPS), who will read - questioning anything not understood - then sign both, accepting responsibility for the work and any other staff working under their supervision. It is the duty of the AP (MGPS) to ensure that the CP (MGPS) understands that no other work should be undertaken during the life of the permit. They should also sign the fourth sheet at this time.

6.106. It is also important to ensure that the CP (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).

6.107. It is important that a risk assessment and method statement is produced to cover the work.

6.108. The yellow copy of the permit should be placed in a protective cover and given to the CP (MGPS) for the duration of the work. The fourth sheet should be retained by the AP (MGPS) and kept in the permit book.

Part 3

6.109. The installation must be ready for examination by the AP (MGPS) at this stage. Part 3 is signed on completion of the work by the CP (MGPS) including, where appropriate, any testing relevant to the work. The AP (MGPS) should witness or participate in the testing routines.

6.110. The AP (MGPS) should satisfy themself that the work has been carried out as prescribed. It is standard practice for the AP (MGPS) to witness or conduct tests considering they are the MGPS responsible person. It would not be considered appropriate for an external specialist contractor to test and pass their own work. Part 3 of the permit should be filled in by the CP (MGPS) to indicate a 'pass' or 'fail' status for each test performed in order to enable the AP (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 AP (MGPS) signs to indicate that the system will not be suitable for pharmaceutical testing and cancels the permit. It is the duty of the CP (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 to instruct the removal of the pipe.

6.111. The CP (MGPS) returns the yellow copy to the permit book, and, with the AP (MGPS), signs part 3 of the white copy (the yellow copy is in place in the book to allow transfer of text).

6.112. The inside cover of the permit book contains a list of relevant tests (proposed for inclusion). 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.

6.113. The AP (MGPS) will then supervise reconnection of the isolated system and any purging with the working gas.

6.114. At this stage, the QC (MGPS) may be present and may request that the AP (MGPS) carry out the purge process or may wish to involve themself in the procedure.

6.115. The AP (MGPS) then invites the QC (MGPS) to carry out the identity and quality tests.

Part 4

6.116. This is completed by the AP (MGPS) and the QC (MGPS) when satisfied that the system may be taken back into use. The 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.

6.117. The AP (MGPS) then informs the DCO (MGPS) that the work is completed and that the MGPS is now ready for use.

Part 5

6.118. This is signed by the DCO (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 their colleagues to this effect.

6.119. The AP (MGPS) should remove any 'do not use' or other prohibition labels and retain the book containing white and green copies of the permit.

6.120. The second (pink) copy of the permit should be given to the QC (MGPS). The CP (MGPS) may wish to keep the yellow copy, but the fourth sheet should remain in the permit book.

Low hazard permit

6.121. The space on the top left of the form allows entry of the hospital/ healthcare organisation name.

Part 1

6.122. 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.

6.123. The AP (MGPS) signs and date's part 1 at the time of discussion (if necessary) with the DCO (MGPS).

6.124. This part of the form also contains space for the predicted timescale of the work and the signature of the DCO (MGPS) (if appropriate).

6.125. Although initial discussions with the DCO (MGPS) take place at the time the AP (MGPS) signs part 1, the DCO (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.

6.126. If work is to be carried out on BS 5682 terminal units only, the statements 'Terminal units have integral isolating valves' or 'Terminal units are to BS 5682' should be included in part 1 under 'The following work is to be carried out'.

6.127. Wherever possible, drawing reference numbers should be identified on the permit. A copy of the relevant drawing should be attached to the permit.

6.128. 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

6.129. This is for the CP (MGPS) to sign just before the work is due to start. The permit (yellow copy) is presented to the CP (MGPS) who will read – questioning anything not understood – then sign part 2, accepting responsibility for the work and anyone working under their supervision.

6.130. At this stage the permit (and its duplicates) is still in the permit book but following signature of part 2 by the CP (MGPS), the yellow copy of the permit should be placed in a protective cover and given to the CP (MGPS) for the duration of the work.

Part 3

6.131. The installation must be ready for examination by the AP (MGPS) at this stage. Part 3 is signed on completion of the work by the CP (MGPS) including, where appropriate, any testing relevant to the work.

6.132. The CP (MGPS) returns the yellow copy 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).

6.133. The AP (MGPS) should fully satisfy themself that the work has been carried out as prescribed. Part 3 of the permit should be filled in by the CP (MGPS) to indicate a ‘pass’ or ‘fail’ status for each test performed in order for the AP (MGPS) to make an informed decision on the suitability of the system for use.

6.134. At this stage, failure of one or more tests will usually indicate that further work on the system will be required.

Part 4

6.135. This is completed by the AP (MGPS) when satisfied that the system may be taken back into use or, alternatively, that further work and hence permit cancellation are required.

6.136. If appropriate, the AP (MGPS) then informs the DCO (MGPS) that the work is completed and that the MGPS is now ready for use.

Part 5

6.137. This section enables the DCO (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.

6.138. The yellow copy of the permit must be in the permit book at this stage to allow transfer of signatures.

6.139. The AP (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 retained in the permit book if not required by the QC (MGPS) as they would not typically be involved in low hazard work. The CP (MGPS) may retain the yellow copy.

Preparation and issue of permit-to-work - examples

6.140. 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

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

Typical maximal work at high hazard

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

Liaison before work

6.143. It is the duty of the AP (MGPS) to ensure that the QC (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

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

(1) Two weeks before the planned interruption

6.145. The AP (MGPS) completes part 1 of the permit-to-work form and liaises in person with the DCO (MGPS) of the ward(s) or department(s) concerned. The DCO (MGPS) are made aware that their signatures will be required on the agreed date on which the work is due to take place.

6.146. The requirement for portable cylinders or vacuum units is determined and confirmed, with details of the interruption, by a memorandum from Estates to the DCO (MGPS).

6.147. A copy of this memorandum is sent to the ward(s) or department(s) concerned.

6.148. A further memorandum requesting the services of the QC (MGPS) and detailing the requirements for portable cylinders is sent to pharmacy and the head porter respectively.

6.149. The AP (MGPS) arranges, through the healthcare, pharmacy and medical engineering departments (or a contract hire firm, if necessary), for portable cylinders and regulators.

6.150. The AP (MGPS) should advise the ward/ department concerned so that they can arrange for the provision of any additional portable vacuum units.

6.151. The AP (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

6.152. Work shall only commence when the DCO (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.

6.153. The AP (MGPS) will by specific instruction, supported by a method statement and sketch issued to the specialist contractor, confirm they are fully conversant with the detail of work involved, to remove any cause for deviation prior to the supervision of the service by isolation and physical break by spading of the AVSU/ LVA(s). The AP (MGPS) will retain the valve key(s).

6.154. Once the system(s) has/ have been isolated and depressurised, the CP (MGPS) signs both part 2 and the fourth sheet of the permit-to-work form and then commences the work. They retain the yellow copy for the duration of the work, while the AP (MGPS) signs the fourth sheet and retains it in the permit book.

6.155. On completion of the work, the CP (MGPS) contacts the AP (MGPS) so that the installation may be examined before testing.

(3) Engineering and pharmaceutical testing of the completed work

6.156. Depending on the extent of high hazard work, the AP (MGPS) determines and (if agreed in the contract) carries out, with the assistance of the CP (MGPS), the necessary engineering

tests and examination of the system(s) in accordance with this Scottish Health Technical Memorandum (SHTM).

Note 9: Contract work may not involve the AP (MGPS) in either determining or actually carrying out the tests – refer to the role of the Contract Supervising Officer (CSO) in Part A of SHTM 02-01. However, good practice dictates that any opportunity to allow participation of the AP (MGPS) should be taken whenever possible.

6.157. On obtaining satisfactory test results, the CP (MGPS) and AP (MGPS) sign part 3 of the permit, signifying that the work is ready for pharmaceutical testing.

6.158. On completion of the engineering tests and examination, the QC (MGPS), with the assistance of the AP (MGPS), carries out identity and quality tests on the system(s) in accordance with this SHTM.

6.159. On obtaining satisfactory results, both sign part 4 of the permit.

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

6.160. The DCO (MGPS) accept(s) the system(s) back into service by signing part 5 of the permit and undertake(s) to inform their colleagues that the system is fit for use.

(5) Copies of permits

6.161. The QC (MGPS) receives the pink copy of the completed permit-to-work form from the AP (MGPS).

6.162. The AP (MGPS) retains the completed white (top) copy in the permit-to-work book together with the fourth sheet.

6.163. Photocopies of the white copy/ fourth sheet may be issued to a CP (MGPS) on request. Alternatively, they may retain the yellow copy.

Low hazard work

Typical minimal work at low hazard

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

Typical maximal work at low hazard

6.165. Maximal work might include the replacement of BS 5682 terminal-unit seals in a whole department. (This requires the signature of a DCO (MGPS)).

Liaison before work

6.166. Where work is pre-planned (for example annual servicing of terminal units), it will be possible for the AP (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.

6.167. 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

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

6.169. The AP (MGPS) completes part 1 of the permit-to-work form and liaises in person with the DCO (MGPS) of the ward(s) or department(s) concerned.

6.170. The DCO (MGPS) is/ are made aware that their signatures will be required on the agreed date on which the work is due to take place.

6.171. The requirement for portable cylinders or vacuum units is determined and confirmed, with details of the interruption, by a memorandum from Estates to the DCO (MGPS).

6.172. A copy of this memorandum is sent to all ward(s) or department(s) involved.

6.173. A further memorandum detailing the requirements for portable cylinders is sent to pharmacy and the head porter respectively.

6.174. The AP (MGPS) arranges, through the healthcare, pharmacy and medical engineering departments (or a contract hire firm, if necessary), for portable cylinders and regulators.

6.175. If more portable vacuum units are required, the wards/ departments concerned should organise this.

6.176. The AP (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

6.177. If required, the AP (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.

6.178. The AP (MGPS) completes the relevant section of part 1 of the permit-to-work form, providing all details of the work to be carried out.

6.179. The AP (MGPS) liaises with, and fully briefs, the senior duty nurse of the ward/ department, who will then also sign part 1.

6.180. When satisfied with the extent of the work, the CP (MGPS) signs part 2 and begins the work.

6.181. On completion of the work, the CP (MGPS) contacts the AP (MGPS) for the installation to be examined and tested.

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

6.182. The AP (MGPS) liaises with pharmacy/ portering for additional labour, if necessary, and cylinders for use on the emergency reserve manifold.

6.183. The AP (MGPS) completes the relevant section of part 1 of the permit-to-work form, providing all details of the work to be carried out.

6.184. When satisfied with the extent of the work, the CP (MGPS) signs part 2 and begins the work.

6.185. On completion of the work, the CP (MGPS) contacts the AP (MGPS) for the installation to be examined.

(2) Engineering tests on completion of work

6.186. **Terminal units**: the CP (MGPS), with the assistance of the AP (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 AP (MGPS) signs part 4 of the permit, signifying that the system is ready for use.

6.187. **Plant**: equipment function tests, and any associated alarm/ monitoring system tests, are made to the satisfaction of the AP (MGPS). When satisfied with the test results, the AP (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

6.188. The DCO (MGPS) for the ward or department accepts the MGPS back into service by signing part 5 of the permit and undertakes to inform their colleagues that the system is ready for use.

(4) Copies of permits

6.189. The QC (MGPS) receives the completed pink copy of the permit-to-work form from the AP (MGPS).

Note 10: Many QC (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.

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

Handing back systems that will not be used immediately

6.191. 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 DCO (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.

6.192. 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 (MA) as described in Section 13 of SHTM 02-01 Part A.

6.193. 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 AP (MGPS) should liaise with both the QC (MGPS) and the DCO (MGPS) to establish a suitably documented handover procedure.

7. Training and communication

General

7.1. A key requirement throughout this document suite is that of competency and the ability to be able to demonstrate the Knowledge, Skills and Behaviours (KSBs) required to perform the relevant functions within the overall design and management of medical gas pipeline systems (MGPS) and supply sources in a suitable and sufficient manner. Crucial to this has been the development of an NHS National Education for Scotland (NES) supported educational training framework in Scotland based on specific National Occupational Standard (NOS) (from the recommendations of the Healthcare Safety Investigations Branch (HSIB) report into oxygen use during the pandemic) for all the designate person disciplines identified within the MGPS speciality area.

7.2. Competency at all levels has been the cornerstone of many recent public inquiry outcomes and this area is soundly addressed within the new suite of guidance from the conceptualisation stage as an informed design process (IDP), to the competent person installing maintain and testing these systems for safe, efficient use for patient therapy.

7.3. 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.

7.4. 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.

7.5. It is essential, therefore, that personnel at all levels have a sound general knowledge of the principles and functions of MGPS.

7.6. No person should operate medical gas systems or equipment unless they are properly trained or supervised.

7.7. All training should be recorded and reviewed regularly.

7.8. The Executive Manager should ensure that all estates/ nursing/ medical staff have received this training before using the MGPS Induction training for any personnel who will be working with medical gases should include the essential elements of medical gas safety and emergency actions.

7.9. All Authorised and Competent Persons (MGPS) (CP (MGPS)) should have satisfactorily completed appropriate medical gas and first-aid training courses before they are appointed.

7.10. It is essential that all training courses include practical elements (for example brazing practice) for CP (MGPS) carrying out installation work, and terminal unit servicing for CP (MGPS) carrying out maintenance. Training in the validation and verification procedures

detailed in Part A of this Scottish Health Technical Memorandum (SHTM) should be included. MGPS compliance assessment and completion of MGPS permits by Authorised Persons (MGPS) (AP (MGPS) should form part of all AP (MGPS) training courses. It is equally essential that documented assessments of practical competencies are made during the training and following from the successful completion of any relevant qualification that the relevant continuing professional development log is maintained and reviewed on a regular basis ideally as part of the of the NHSScotland 'TURAS' personal development review for directly employed staff or as part of the annual review for contracted services.

7.11. However, as AP (MGPS) are expected to satisfy themselves of the competence of any employed or contracted staff, it will be expected that all prospective CP (MGPS) are able to offer documentary evidence of training in basic competencies and having obtained the same Scottish Qualifications Authority (SQA) qualifications as staff who are directly employed by a healthcare organisation. Contractors and/ or their staff unable or unwilling to provide such evidence should not be allowed to work on medical gas systems.

Familiarity with systems and equipment

7.12. 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 off-site training centres, or when attending training courses at other healthcare facilities, both of which may use different types of equipment and/ or system configurations.

7.13. Familiarisation with central plant operation is essential; in particular, those procedures ensuring continuity of supply in the event of failure of the plant.

7.14. It is essential that time is allocated for this familiarisation process, and personnel should not be appointed as AP (MGPS), CP (MGPS) or Designated Clinical Officers (MGPS) (DCO (MGPS)) without sufficient experience and familiarisation with their particular installations and/ or equipment. Similarly, staff with the responsibility for medical gas cylinder handling and changing medical gas cylinders on manifold systems should receive suitable training.

Refresher training and reassessment

7.15. The new suite of NOS for the MGPS discipline are individually awarded qualifications at grades dependent upon the level of responsibility and autonomy involved and are assessed and credit rated educational packages. There is no requirement to retake these qualifications after a defined time period, maintaining Continuing Professional Development (CPD) is the route to demonstrating ongoing competency and currency in an individual's KSBs for the chosen discipline.

7.16. If the responsible individual felt, or as the result of an annual review revealed that training in specific areas was required this could be addressed by a refresher course or a guided

program of learning as agreed with the relevant assessor. It is the individual's responsibility to maintain the CPD and fitness to practice in the chosen specialism. The recommendation for appointment or reappointment as an (AP(MGPS) should be made by an Authorising Engineer (MGPS) (AE (MGPS)).

7.17. The Quality Controller (MGPS) (QC (MGPS)) have their own training qualifications and forms of professional development to retain their relevant professional body registration and to prove their fitness to practice. They should also receive specific training/ familiarisation covering the equipment, responsibilities and duties which they will be required to carry out for the sites that they are providing a service to.

7.18. 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.

7.19. DCO (MGPS) will require more detailed training in specific areas such as emergency procedures and use of the permit-to-work system.

Training records

7.20. 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, with relevant professional bodies from a professional qualification perspective.

7.21. AP (MGPS) records will be kept by both the AP (MGPS) and the AE (MGPS).

7.22. CP (MGPS) directly employed by the healthcare organisation will be assessed by the AP (MGPS) as competent to perform the required work, and records of appropriate training and experience will be kept by the AP (MGPS) and the CP (MGPS).

7.23. Contractors providing CP (MGPS) services will be expected to maintain relevant records and produce these on request by the AE (MGPS) or AP (MGPS).

Limitation of activities

7.24. Evidence of experience and training will be used to determine both the limits of authorisation of an AP (MGPS) and the scope of work carried out by a CP (MGPS). For example, following an assessment exercise, an AE (MGPS) may decide that an AP (MGPS) is insufficiently experienced or familiar with an MGPS to write permits for high hazard work. In such a case, the AE (MGPS) will produce a written statement to this effect and also make recommendations for further training and/ or familiarisation.

7.25. The training needs of estates staff not registered as CP (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 AP (MGPS).

Training course content and transition to NOS framework

7.26. The framework of NOS qualifications being adopted by NHS NES, together with professional registration for QC pharmacists through their own professional bodies will mean that all roles of designated responsibility, apart from staff cylinder management, connected with MGPS and medical gas use and operation will have a nationally approved credit rated qualification which will prove competency through its multi-faceted assessment processes for demonstration of the relevant KSB's to confidently and professionally manage and deliver medical gases safely and efficiently. These SQA qualifications and the level 7 award for DCO (MGPS) are illustrated in Table 7.1 and paragraph 7.30.

7.27. These links will give a full description of the training and assessment criteria and the learning outcomes that will be expected to be demonstrated and assessed to prove competency for award

7.28. It is realised that with such a marked step in the improvement of training and assessment for competency that it will not happen overnight and a 3-year transition period (from the issue date of this SHTM) will be typical before the new framework will become embedded in the culture of the health boards and healthcare facilities. It is envisaged that this process will start at the top and work down with the AE (MGPS) role becoming the first professionally recognised qualification with successful applicants being awarded the post nominals of Post-graduate Diploma (PG Dip) AE (MGPS), full information on this can be found from the SQA and NES websites.

Table 7.1 - MGPS qualifications

Qualification title	SQA Accreditation Qualification Number
Award in Installation of Medical Gas Pipeline Systems: Competent Person (Scottish Credit and Qualification Framework ((SCQF) Level 6)	R822 04
Award in Maintenance of Medical Gas Pipeline Systems: Competent Person (SCQF Level 6)	R823 04
Certificate in Medical Gas Pipeline Systems: Authorised Person (SCQF Level 8)	R824 04
Diploma in Medical Gas Pipeline Systems: AE (SCQF Level 11)	R825 04

7.29. The qualification for the DCO role is a level 7 award and the full title of the unit is 'Award in Management of Medical Gas Supply: Designated Clinical Officer (EduQual Level 7)' it is a key role for the safe and professional management and operation of medical gases and MGPS within healthcare facilities and provides a vital link between clinical and operational delivery requirements. The exact numbers of DCO's required will be dependent upon the size acuity and complexity of the health board and its facilities.

Staff - cylinder management

Course content

7.30. 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

7.31. 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 and the like
- **B.** a general introduction to plant that healthcare 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
- **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 11:

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

Learning outcomes

7.32. 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 a healthcare facility 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 directives

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

7.33. Medical gas systems are specialised services requiring considerable expertise in design, installation, validation and verification. The IDP and subsequent risk management processes, as described in Section 1 of Part A need to be fully adhered to by practitioners who are engaged in the design of MGPS.

7.34. 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)

7.35. An AE will be a Chartered Engineer (CEng) in an appropriate engineering discipline.

7.36. The AE will:

- have attended an accredited AE (MGPS) training course specific to the needs of the role (described above) and hold the relevant post nominal PG Dip AE (MGPS) from a suitably accredited body
- provide documentary evidence of formal qualifications, technical, design and contractual experience including records of CPD
- by means of a formal interview, satisfy the appointing body of their ability to perform the role safely, conscientiously and effectively

Authorised Person (MGPS)

7.37. The AP (MGPS) will:

- possess a minimum of three years' relevant professional experience
- have attained the qualification ref SQA 824 04 and maintain their CPD requirement to continue as a skilled practitioner possess an adequate knowledge of health and safety aspects of MGPS plant and components, this SHTM, 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
- by means of a formal interview, satisfy the AE (MGPS) of their familiarisation with the MGPS for which they will assume responsibility and their 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)

7.38. The CP (MGPS) will:

- have completed or be in the process of completing (for example, the final year of a relevant apprenticeship), relevant modules of the Advanced Modern Apprenticeship Scheme or possess recognised formal electrical/ mechanical qualifications)
- where the CP (MGPS) is a final year apprentice, the AP (MGPS) will determine the level of responsibility and activities which can be performed
- possess a minimum of three years' relevant experience

7.39. They will also:

- have attained either or both (as required) of the qualification ref SQA 822 04 or SQA 823 04 and maintain their CPD requirement to continue as a skilled practitioner by means of a formal interview, have satisfied the appointing AP (MGPS) of their familiarisation with the MGPS on which they will work and their ability to perform the role safely, conscientiously and effectively.

Note 12: For contractor's staff, the CP (MGPS) 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)

7.40. Only individuals who have been appointed to the QC (MGPS) register may act as QC (MGPS).

7.41. Appointments to the QC (MGPS) register will be made only by regional quality control pharmacists.

7.42. Inclusion on the register will normally be sufficient to qualify an individual to act as QC (MGPS) for any healthcare organisation. However, the healthcare organisation's chief pharmacist may exercise the option to specify, or otherwise limit, those registered as QC (MGPS) who may operate on their site.

7.43. The QC (MGPS) will:

- be a graduate who is eligible for membership of the Royal Pharmaceutical Society of Great Britain (RPSGB) (now Royal Pharmaceutical Society (RPS)), the Royal Society of Chemistry (RSC) or Institute of Biology
- have successfully completed an accredited training course for QC testing of medical gases and piped medical gas systems
- have had extensive practical experience of QC testing of medical gases and piped medical gas systems

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

Requirements for appointment of Designated Clinical Officers (MGPS)

7.44. Decisions on appointment to these functions should be carried out at local level, based on experience and possession of the basic skills outlined above and having obtained or be in the process of obtaining the qualification of DCO (MGPS), see paragraph 7.27.

7.45. It is recommended that such appointments are discussed with the AP (MGPS) and the AE (MGPS) to arrive at a structure which is workable in routine and emergency situations.

7.46. It is essential that persons nominated into these roles are given training in accordance with the recommendations in this SHTM and maintain suitable CPD.

7.47. 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 Staff - Cylinder management

7.48. Given the wide variation in line management responsibilities for staff carrying out cylinder management duties 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 SHTM.

7.49. Local circumstances may demand additional training and experience if, for example, the member of staff is to work in a specified department or with particular types of equipment or gases.

7.50. 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

7.51. It is feasible that any one person could be suitably qualified and experienced to act in two or more of the above roles.

7.52. However, in the interests of patient safety, it is essential that independence of functional responsibilities is maintained.

7.53. For example, it is not acceptable that a person acting as a QC (MGPS) also acts as AP (MGPS) and/ or CP (MGPS) for the same job.

7.54. Similarly, an AE (MGPS) who will also be qualified as an AP (MGPS) should not carry out work as an AP (MGPS) that they then self-validate.

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

Communications

7.56. 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.

7.57. 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.

7.58. Lines of communication during emergencies and outside normal working hours are particularly important and should be clearly documented in the policy.

7.59. 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.

7.60. It is recommended that a Medical Gas Safety Group (MGSG) be established to oversee the general operation and management of the MGPS, and all facets of the MGPS operational policy including the policy review. The MGSG should be chaired by the Chief Pharmacist/ Senior Operational Manager, and report to the Executive Manager.

7.61. Other personnel can be invited to attend MGSG meetings, depending on 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 3.45 - 3.47).

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 the European Pharmacopoeia (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 (MA).

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).

Note 13: 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:

- group 1 - flammable
- group 2 - oxidising
- group 3 - toxic or corrosive (the contents may also be flammable or oxidising)
- group 4 - others (including inert gases)

The most common gases, grouped as above, likely to be used in health buildings are shown in Table 8.1 - Classification of gas cylinders.

Labelling/ marking of cylinders

8.7. Cylinders should be colour-coded and marked in accordance with British Standard (BS) European Standard (EN) International Standard (ISO) 407, the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2004, and European Directive 2004/27/EC. Each cylinder should have:

- a batch label to include a unique batch number, filling branch code, cylinder code and product, filling date and expiry date
- a product identification label which includes:
    - the product licence number
    - 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
    - a hazard warning sign
    - a substance identification number
    - specific product and cylinder handling precautions
    - particular instructions to the user where necessary
    - safety information
- a serial number
- test mark, year and quarter of test.

Table 8.1 - Flammable and explosive classification of gas cylinders

Group classification of gas cylinder contents	Medical gases	Non-medical gases
• Flammable • (red diamond on label)	• N/A	• Acetylene • LPG (liquified petroleum gas) (for example, propane, butane) • STG (synthetic town gas) • Methane • Natural gas • Hydrogen

Table 8.2 - Oxidising classification of gas cylinders

Group classification of gas cylinder contents	Medical gases	Non-medical gases
• 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

Table 8.3 - Toxic and corrosive classification of gas cylinders

Group classification of gas cylinder contents	Medical gases	Non-medical gases
• Toxic and/ or corrosive and flammable	N/A	• Ammonia • Ethylene oxide (C_2H_4O) • Carbon monoxide • Ethylene oxide/ carbon dioxide mixtures >6% C_2H_4O

Group classification of gas cylinder contents	Medical gases	Non-medical gases
• Toxic and/ or corrosive and oxidizing	N/A	• Nitric oxide mixtures • Sulphur dioxide • Chlorine
• Toxic and/ or corrosive only	N/A	• Ethylene oxide/ halocarbon mixtures <15% C_2H_4O (certain conditions only) • Ethylene oxide/ carbon dioxide mixtures <6% C_2H_4O

Table 8.4 - Other classifications of gas cylinders

Group classification of gas cylinder contents	Medical gases	Non-medical gases
• 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

8.8. Cylinders, pressure-reducing regulators and pressure gauges should be conspicuously marked ‘use no oil, grease or hand creams and the like’ 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 may be used as guidance.

8.9. Pressure gauges should be in accordance with BS EN 837-1, with the appropriate standard for the particular type of medical equipment.

Cylinder colour codes

8.10. Refer to the relevant gas suppliers Cylinder Data Chart for cylinder colour codes.

Cylinder sizing and naming

8.11. Refer to the relevant gas suppliers Cylinder Data Chart for cylinder sizes and the like.

Medical gas cylinder valve types

8.12. There are five basic valve types:

8.13. The five valves:

- Bull nose valve 5/8” British Standard Pipe (BSP) (F) BS 341 No. 3
- Hand wheel 11/16”x 20 threads per inch (TPI) (M) BS 341 No.13
- Valve with integrated pressure regulator (VIPR)
- Pin indexed Internation Standard (ISO) 407 valve
- European Standard (EN)/ ISO 5145 series valve

8.14. 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.

8.15. 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.

8.16. The VIPR combines a regulator and valve as a single unit. They are operated by a hand-wheel and are fitted with a variety of outlets. A range of output flow rates is also available. They are fitted to some sizes Heliox 21, Entonox, MA and oxygen cylinders.

8.17. 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 nitrous oxide/oxygen mixture (50%/50%) cylinders.

8.18. Pin-index valves with a side spindle (‘J’-size oxygen and MA for manifolds) should be operated with the correct key.

8.19. EN/ ISO 5145 valves These are the new series of valves designed to meet the requirements of high pressures cylinder applications and to comply with the British Compressed Gas Association (BCGA) Technical Information Sheet (TIS) 21 guidance for gas specificity and pressure they are a much more effective design for quick coupling without tools and offer enhanced sealing characteristics against leakage than from existing seal configurations.

Note 14: Notes for valves attached to medical gas cylinders:

a. the pin-index valve is not fitted to 'G'-size MA 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.

Cylinder safety - main principles

8.20. The main hazards associated with gas cylinders are:

- careless storage, handling, dropping or impact can cause physical or personal injury. These hazards should be minimised by:
  - the correct design, siting and construction of cylinder storage areas
  - the provision of suitable storage and handling equipment and
  - the adoption of safe operating practices
- 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

8.21. 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.

8.22. Storage facilities should be designed to the recommendations of Scottish Health Technical Memorandum (SHTM) 02-01 Part A, 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. Additional guidance is provided in BCGA's Code of Practice (CP) 44 - 'The storage of gas cylinders'.

8.23. The decanting and filling of medical gas cylinders is subject to specific legislation out with the scope of this SHTM and should not be carried out on a healthcare site.

Main stores

8.24. 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 CP 44 - 'The storage of gas cylinders'.

Ready-to-use stores

8.25. 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 and Emergency departments, coronary care units, central delivery suites of maternity departments, special care baby units, critical care areas and the like.

8.26. 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.

8.27. 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 and the like and other operational reasons.

8.28. 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.

8.29. This designated room should be clearly labelled with the types of cylinder contained and 'no smoking' warning signs.

8.30. No combustible material should be kept in the ready-to-use store. The general principles provided in Section 12 of SHTM 02-01 Part A should be followed.

8.31. Cylinders should be stored in racks in accordance with BS EN ISO 407.

8.32. Sufficient space should be provided for manoeuvring cylinders onto and off trolleys. Adequate means of securing large cylinders should be provided to prevent falling.

8.33. Small cylinders of oxygen/nitrous oxide mixtures should be kept horizontal and placed away from ventilation openings where practicable.

8.34. 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.

8.35. A good stock of cylinder keys should be kept in/ near the store.

Local storage (wards)

8.36. Cylinders of MA/ 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.

8.37. All staff should be made aware of the location and function of these cylinders.

Local storage (non-specific storage areas)

8.38. 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.

8.39. 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

8.40. Manifold rooms should not generally be used as general cylinder storage areas (but see paragraph 8.49).

8.41. 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 8.44 - 8.49).

Note 15: 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.

8.42. 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.

8.43. In the case of manifolds for nitrous oxide/oxygen mixtures, sufficient cylinders to replace two complete banks should be stored.

Exceptions

8.44. 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.

8.45. Some sites, in the absence of a dedicated building, will also store small cylinders of all medical gas types in medical gas manifold rooms.

8.46. In such cases, the Authorised Person (medical gas pipeline systems (MGPS)) (AP (MGPS) should complete a risk assessment to validate the storage of such cylinders in the manifold room.

8.47. 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 8.146).

8.48. The AP (MGPS) should ensure that appropriate training is being carried out on an ongoing basis.

8.49. 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.

Location

8.50. The location of the cylinder store should be marked clearly on the site plan for ease of identification in the event of an emergency.

Signage and labelling (including Hazchem signs)

8.51. The following signs should be posted:

- safety signage (Hazchem notices) in accordance with the requirements of the Health and Safety (Safety Signs and Signals) Regulations 1996, BS 5499-5 and the Health and Safety at Work etc Act 1974 should be posted in and outside any area where cylinders are stored
- a store identification notice. Suitable wording could be: ‘Medical gas storage area – smoking, welding and naked lights prohibited’
- a store contents notice, clearly indicating the contents of the store
- a medical gas cylinder identification chart and other relevant safety warning charts, posted inside the store
- 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

8.52. Clear and secure access to all cylinder stores is required, including adequate space for vehicular access and cylinder loading/ unloading.

8.53. 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 they enter the healthcare facility site. The transparent front of the box should be labelled: 'Break cover to obtain key for emergency use only'.

8.54. Where this would not be desirable for security reasons, a prominent notice clearly stating the location of the key should be displayed.

8.55. 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.

Emergency access/ exit

8.56. 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

8.57. All cylinder stores should be free from naked flames and all sources of ignition and should be designated 'no smoking' areas.

8.58. 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.

8.59. General fire precautions applicable to MGPS are provided in Section 9 of this Scottish Health Technical Memorandum (SHTM).

8.60. Fire detection should be installed in ready-to-use medical gas cylinder stores in healthcare facilities with an automatic fire detection system in accordance with 'Firecode'.

Electrical installations/ lighting

8.61. Electrical installations in gas storage areas are addressed by the current edition of BS 7671 'Requirements for Electrical Installations', including all current amendments and associated guidance documents, BS EN 60079-10-1 and BS EN 60079-14.

Note 16: BS EN 60079-10-1 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.

8.62. On a hospital site, BS EN 60079-10-1 supports the Dangerous Substances and Explosive Atmospheres Regulations 2002.

Segregation of gases/ cylinders

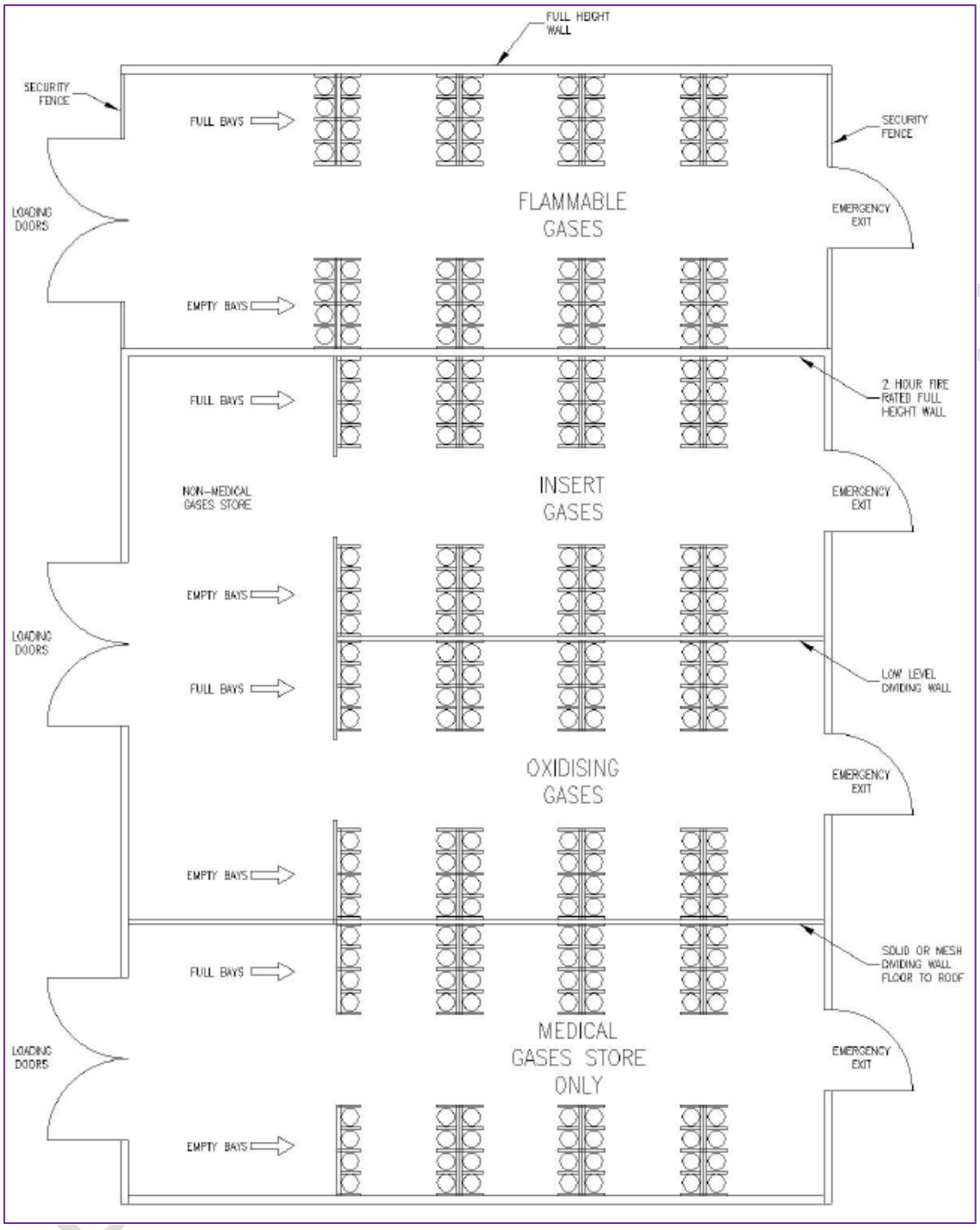
8.63. Cylinder stores for medical gases should only contain medical gas cylinders.

8.64. Industrial and pathology gases cylinders should be stored in a separate, appropriately designated store.

8.65. Separate, clearly identified bays should be provided for full and empty cylinders.

8.66. 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 8.1).

Figure 8.1 - Cylinder storage for medical and non-medical gas cylinders



Cylinder restraint

8.67. Adequate means of securing large cylinders should be provided to prevent falling.

8.68. Smaller cylinders should be stored horizontally on metal racks, suitably protected to prevent damage to cylinder paintwork.

8.69. 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

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

Store temperature

8.71. 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.

8.72. 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

8.73. The store must be kept clean, dry and free from flammable material. Rubbish, chemicals and the like 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

8.74. Appropriate safety signage should be provided in all cylinder stores in accordance with Appendix 3 of BCGA CP 44.

Handling of cylinders

General

8.75. 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.

8.76. Cylinders should not be dropped, knocked, used as ‘rollers’, or be permitted to strike each other violently.

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

> Note 17: 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.

8.78. Cylinders should not be marked with chalk, crayon, paint or other materials, or by the application of adhesive tapes and the like. A tie-on label indicating the content state may be attached to the cylinder.

8.79. Smoking and naked lights should be prohibited in the vicinity of all cylinders.

8.80. Cylinders should always be secured during transportation and in use.

8.81. Safety devices, including pressure-relief devices, valves and connectors should not be altered or by-passed.

8.82. Repairs, alterations or modifications should not be undertaken.

8.83. Markings used for identification of cylinder contents, pressure-testing of cylinders, tare weights and the like should not be defaced or removed. This also applies specifically to cylinder product labels.

8.84. 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.

8.85. Cylinders used for industrial purposes should not be used for medical applications. Similarly, medical gases should not be used for non-medical applications.

8.86. Cylinder valves should not be dismantled or tampered with.

8.87. Leaking cylinders should be removed from service and returned to the gas supplier (see paragraphs 8.125 - 8.135).

8.88. Cylinder valves should always be closed after use and when cylinders are empty. Keys/ spanners for this purpose should be readily available. Any gas trapped within the regulator/ equipment should be safely vented to atmosphere and the equipment valves re-closed.

Protective clothing

8.89. 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 and the like.

8.90. Additional precautions are required for handling cryogenic gases (see paragraphs 8.151 - 8.159)

> Note 18: 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

8.91. A suitable trolley, conforming to BS 2718, should be used for transporting cylinders whenever they are moved.

8.92. 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 and the like, and they should be reserved for the transportation of gas cylinders.

8.93. Precautions should be taken to prevent cylinders falling from trolleys, trucks or vehicles.

8.94. 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

8.95. 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 and the like. Care should be taken to avoid transfer of oil, grease and hand creams and the like from the winch to cylinders.

8.96. Cylinders should not be lifted by their guards or valves unless specifically designed for that purpose.

Transportation of cylinders with attached equipment

8.97. 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.

8.98. 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.

8.99. When serving a patient, equipment and cylinders must be secured during transportation to prevent injury and interruption of supply. For moving large cylinders, the use of trolleys with a third (or more) rear-mounted wheel(s) is strongly recommended.

Note 19: Specially designed cylinder carriers are available for both wheelchair and patient transport trolley and these must be used.

Preparation of cylinders for use

8.100. To ensure patient and staff safety, Medical Device Alert (MDA) Safety Notice (SN) 2000(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 and the like (for example barrier creams)
- users open medical gas cylinders slowly
- 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)
- users read, understand and follow all instructions and labelling provided by the manufacturer/ supplier

Note 20: 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 limit this occurrence.

8.101. Cylinders and their associated equipment should be protected from contact with oil, grease and hand creams and the like, bituminous products, acids and other corrosive substances.

8.102. Equipment should be subject to planned preventive maintenance (PPM) (see Section 10).

8.103. Defective equipment should be notified to the appropriate body in accordance with the defect reporting system (see Section 3).

8.104. Cylinder preparation checklist:

- check the cylinder label to ensure the correct gas has been supplied
- the tamper-evident seal should be removed, and any plastic outlet cap removed and left attached to the valve for refitting after use
- cylinders should only be used in conjunction with equipment designed for their use
- 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
- 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 and the like, and other debris
- 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
- 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
- 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 21: 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

8.105. Undue force should not be used to open or close cylinder valves, or to attach connectors to cylinders.

8.106. 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.

8.107. 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 and the like that may be present.

8.108. 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.

8.109. If there is any leakage of gas, the cylinder should be removed from service and returned as faulty.

8.110. Do not attempt to tighten gland nuts and the like, as this may cause damage to the valve.

8.111. 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

8.112. Designated staff (typically Porters or Maintenance Assistants) with specific medical gas training will generally be responsible for the connection and disconnection of cylinders.

Note 22: 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.

8.113. The following procedure, titled ‘Manifold cylinder-changing procedure for designated staff’ may be posted on the manifold room wall adjacent to the manifold.

- 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

Note 23: 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 and the like; 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
- follow procedures for venting header line if applicable
- connect the cylinder to the manifold and tighten firmly by hand or with an appropriate spanner. Do not put undue strain on the manifold tailpipe 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 24: 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 the correct pressure as indicated on the cylinder data sheet or ‘full’ and check the number of cylinders changed and readings on line pressure and contents gauges
- complete the cylinder change logbook
- 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

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

- outside normal working hours, it is the responsibility of the ‘supervisor’ to ensure that all appropriate designated staff comply with the above manifold cylinder-changing procedure
- 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), the Estates department 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
- the handles attached to the nitrous oxide tailpipes are not spanners. They are used to restrain the tailpipe while the appropriate spanner is used to tighten the connecting nut. Using the handle as a spanner will cause serious damage to the tailpipe and may result in personal injury

- 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

8.115. 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 25: Always make sure that you are connecting equipment designed for the gas. Oxygen and MA flowmeters read differently if interchanged.

8.116. The threads connecting different gas flowmeters to a regulator may be the same (for example oxygen and MA). Nitrous oxide/ oxygen mixture flowmeters have a different thread from others.

8.117. Do not use a normal ward flowmeter (0 - 15 litres/min) when a paediatric type should be used (0 - 1.5 litres/min).

8.118. 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.

8.119. 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.

8.120. The connection procedure is as follows:

- prepare the cylinder for use as above
- check the sealing washer at the valve/ connector interface
- connect the cylinder to the equipment and tighten firmly with the correct spanner or by hand (as appropriate). Do not use excessive force
- before opening the cylinder, check that the equipment and other flow control valves are turned off
- for two-stage regulators, turn the outlet pressure control to ‘off’, usually fully anticlockwise
- using the correct key (or knurled valve knob), open the cylinder valve slowly, fully anticlockwise and then back a quarter turn
- 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 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

Note 26: If a leak still persists, the equipment may need to be replaced. The manufacturer and/ or electronic and biomedical equipment (EBME) department should be informed, as appropriate, in accordance with the operational policy.

- If a leak is identified 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 8.124 - 8.133)
- slowly adjust the pressure regulator/ flow controller to the correct setting
- open equipment flow control valve(s) slowly, checking for correct equipment operation

Safety Notes

8.121. Further safety considerations for medical gas cylinders:

- 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

8.122. The disconnection procedure is as follows:

- 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 tailpipe will vent as the cylinder connection is loosened
- shut off any equipment control valves

- using the correct spanner (or by hand), disconnect the cylinder from the equipment or tailpipe
- do not vent the cylinder or leave the cylinder valve open
- replace plastic valve covers on ‘F’ and ‘G’-size cylinders
- 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

8.123. Gas suppliers usually classify defective cylinders under two categories: ‘faulty’ and ‘incident’.

Faulty cylinders

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

Table 8.5 - Faulty cylinder examples

Category	Fault example
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

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

Table 8.6 - Incident cylinder examples

Category	Incident example
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 27: Cylinders involved in a fire or having ignited are also classified as incident cylinders.

Dealing with defective cylinders

8.126. The MGPS operational policy should contain an appropriate procedure. The general procedure outlined in paragraphs 8.123 - 8.132 can be used as the basis for the policy entry.

General procedure

8.127. 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

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

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

8.130. Local reporting procedures (for example to pharmacy) should be followed, particularly in the case of incident cylinders.

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

8.132. 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.

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

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

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

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

Stock control and receipt of cylinders into stock

8.137. 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

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

8.139. 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, BS EN ISO 407, BS ISO 5145 and the relevant parts of BS 5045.

8.140. 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.

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

Returns to suppliers

8.142. 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

8.143. The following should be implemented:

- a written procedure should detail the system by which cylinders are requisitioned for use
- 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

8.144. 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.

8.145. 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.

8.146. An adequate number of keys should be available.

Receipt of cylinders into stock

8.147. 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)
- there should be a tamper-evident seal over the valve outlet

Procedures for the rotation of stock

8.148. A written procedure should be prepared, giving details of a rotational stock-control system.

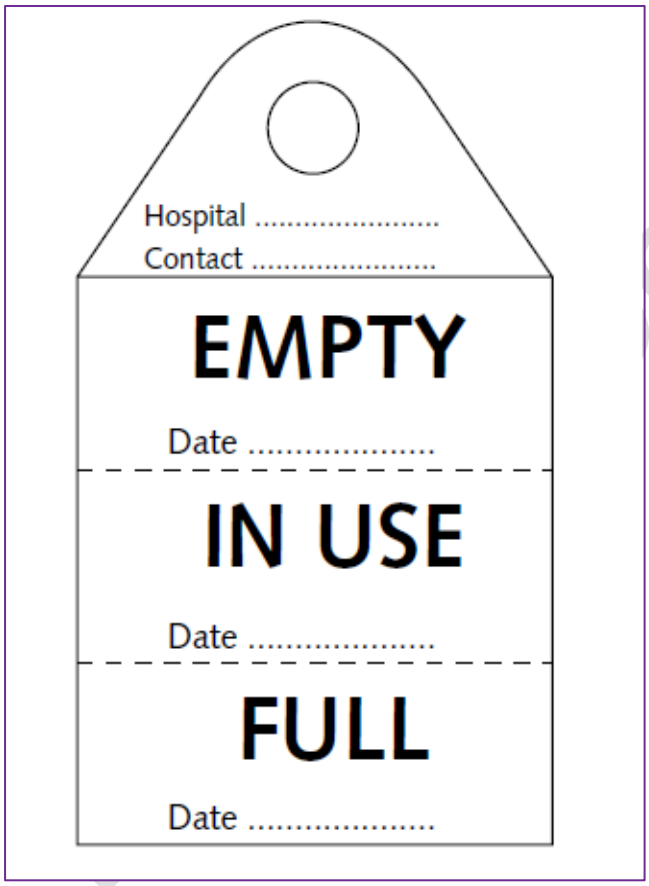
8.149. The main store should be large enough to permit the use of a rotational stock-control system. Racks for small cylinders should be designed to assist rotation of stock.

8.150. 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

8.151. 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 8.2, below.

Figure 8.2 - Example of cylinder contents status label



Note 28: 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

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

Storage

8.153. Dedicated, well-ventilated and signed areas should be allocated to the storage of cryogenic liquids.

8.154. Dewars and larger vessels should not be stored in medical gas cylinder stores.

Note 29: Reference should be made to the BCGA CP 30: ‘The safe use of liquid nitrogen dewars’.

Protective clothing

8.155. Protective clothing is only intended to protect the wearer from accidental contact with liquefied atmospheric gases or parts in contact with it.

8.156. 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.

8.157. Goggles or a face mask should be used to protect the eyes and face where spraying or splashing of liquid may occur.

8.158. 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.

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

8.160. 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.

Note 30: 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 CP 30 detailing safety requirements and procedures in the storage, use and handling of liquid nitrogen dewars should be consulted before this gas is used. This document also gives advice on the safe transport of dewars in hospital lifts.

9. General safety

General

9.1. The safety of medical gas pipeline systems (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 and the like, and by the adherence to strict testing and commissioning procedures of the system.

9.3. The adequacy of supply depends upon the quality of the informed design process (IDP) and the subsequent risk management procedures as described in Section 1 of Scottish Health Technical Memorandum (SHTM) 02-01 Part A.

9.4. Continuity of supply is achieved by the appropriate specification of systems during the IDP (see Section 1 of SHTM 02-01 Part A) that have primary, secondary and tertiary (third) means of supply and the rigorous application of the risk management process. 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 safety power supply system.

9.5. Quality of supply is achieved by:

- the use of gases purchased to the appropriate European Pharmacopoeia (Ph. Eur.) requirements or produced by plant performing to specified standards
- the maintenance of cleanliness throughout the installation of the system
- 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 area valve service units (AVSU) and line valve assemblies (LVA) 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 Section 6.

Safety statement for users of oxygen equipment

9.9. Oxygen enrichment above 20.9% will aid a fire and have an accelerant effect on its fire growth rate. At 23% materials are twice as flammable as in ambient air, however oxygen has a great affinity for forming a 20.9% mixture with nitrogen (commonly known as air) and diffusion from very high concentrations takes place in small distances. Even when filling liquid oxygen vessels, at a distance of 1 metre from the cloud the level will be down to 25% and back to normal air concentrations within another metre.

9.10. The main control measures for this in a ward area will be the air change rate which dilutes and removes the excess, in some repurposed areas and older units it may well not be as high (minimum 6-10 air changes per hour (AC/h)) as current design requirements suggest. The average intensive care unit (ICU) volume is circa 1340m^3, this equates to 1,340,000 litres multiply this by four for 4 AC/h and this equates to a very large number, so high flowrates would be required to start raising concentrations significantly. This argument is less applicable for side rooms and small, confined areas but still needs to be borne in mind. In reality the oxygen level will not be uniform throughout the area but will be high at source of generation and quickly diminish as the distance from source increases. Therefore, it is important to remember this and what needs to be employed as control measures. A fire needs three things, oxygen, fuel, and a source of ignition. So, if one (oxygen) is causing a problem and is hard to control there are still the other two parts of the fire triangle that can be managed.

Fuel

9.11. Oxygen on its own is not a fire hazard, no fuel no fire. There will not be a flashover type event in an enriched oxygen atmosphere without a fuel, be that flammable vapours, combustible dusts and the like which are unlikely. The prime source of fuel within an ICU area will be clothing and bedding and if this becomes enriched it will create a hazard. Simple measures such as a plastic barrier apron placed around the patient's neck and over their clothes/ bedding will cause the oxygen to roll off the smooth surface and dilute with the surrounding air rather than be trapped by the surface of a woven fabric. Consideration also needs to be given to the sensible use of emollients and oil/ alcohol-based products and removing excess or letting it dry before bringing into a potentially enriched zone.

Source of ignition

9.12. There are very few sources of ignition that are not controlled in an ICU, the management of naked flames or incandescent materials is readily achievable. It is to be noted, that the recent spate of ICU fires in Europe and Asia have occurred in ventilators. Ventilators have always been a risk as they have all three elements in the one place and if not properly maintained and inspected, will and do catch fire. Due to the work of Electronic and Bio-Medical Engineering (EBME) departments, ventilator fires are a very rare occurrence in this country, and an enhanced oxygen concentration has little bearing on this type of incident.

Oxygen safety considerations

9.13. 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.

9.14. 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.

9.15. When oxygen is being administered in paediatric departments, the text should include the precaution: ‘Only toys approved by the healthcare organisation fire officer may be given to the child.’

9.16. 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.

9.17. Considerations may need to be given for signs in other languages.

9.18. 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.

9.19. 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

9.20. 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

9.21. See paragraphs 8.152 - 8.159 for more detailed safety instructions on liquefied atmospheric gases, the advice of the supplier should be sought.

Other medical gases

9.22. Guidance available from the manufacturers should be followed.

Fire precautions

9.23. The general guidance on fire precautions given in ‘Firecode’ should be followed. Specific guidance on fire precautions relating to cylinders is given in Section 8.

9.24. Guidance is also available from the gas supplier; any specific recommendations should be followed.

9.25. Fire can occur when the following three conditions are present:

- flammable materials
- oxidising atmosphere
- ignition

9.26. 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.

9.27. 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.

9.28. An oxygen-enriched atmosphere may be present when medical oxygen or nitrous oxide/ oxygen mixtures are used. Nitrous oxide also supports combustion.

9.29. Further guidance should be obtained from the fire prevention officer, the fire safety officer and the local fire brigade.

9.30. 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 and electronic 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 and the like are present

9.31. 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.

9.32. 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.

9.33. Oil, grease and hand creams and the like, even in minute quantities, are liable to ignite in the presence of high-pressure oxygen or nitrous oxide. No oil, grease or hand creams and the like should be used in any part of the MGPS. In particular, oil-based lubricants should not be used, and all fittings, pipes and the like should be supplied degreased, sealed and labelled for MGPS. Details of these requirements are given in SHTM 02-01 Part A.

9.34. The siting and general structural principles for the design of liquid oxygen storage accommodation are stated in Section 5 of SHTM 02-01 Part A, and for plantrooms and gas manifold rooms in Section 12 of SHTM 02-01 Part A. Cylinder storage should be as recommended in Section 8.

Ventilation

9.35. Waste anaesthetic gas discharges are usually controlled by scavenging and/ or ventilation to comply with the requirements of Control of Substances Hazardous to Health (COSHH) Regulations 2002. Where oxygen is used for specific therapies, for example in oxygen tents or in continuous positive airway pressure (CPAP) ventilation regimes, oxygen enrichment may occur. It is essential, therefore, that adequate general ventilation is provided to avoid the hazard.

Note 31: A risk assessment should be carried out to assist the need for local oxygen enrichment monitoring.

10. Maintenance

General

10.1. Medical gas pipelines systems (MGPS) should be subjected to a planned preventive maintenance (PPM) schedule, which should be under the responsibility of the Authorised Person (MGPS) (AP (MGPS)), irrespective of whether or not a full preventive maintenance scheme is being implemented in the healthcare facility.

10.2. All work should be carried out in accordance with this Scottish Health Technical Memorandum (SHTM), manufacturers recommendations and from recognised maintenance specifications such as Service and Facilities Group (SFG)20 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 AP (MGPS).

10.4. All work carried out should be subject to the permit-to-work system and accepted by the AP (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:

- on a contract basis by an approved specialist company (see paragraph 10.9)
- by properly trained directly employed staff (essential for daily, weekly and other tasks)
- by a combination of the above with a clear division of responsibility. For example, filter and oil changes performed by directly employed staff; the remainder of the PPM work performed by contractors

10.7. Since the AP (MGPS) is responsible for the operation of the MGPS, they will decide (in liaison with the quality controllers (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 be carried out by specialist contractors who are registered to British Standard (BS) European Standard (EN) International Standard (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 section.

10.10. The contractor should satisfy the healthcare organisation that the maintenance tasks comply with the Pressure Systems Safety Regulations 2000.

10.11. The healthcare organisation should have a medical gas operational policy that includes effective maintenance and sourcing of MGPS services. The appropriate contractor should provide 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

10.12. The healthcare organisation should not be required to test the competency of contractors' staff, but it is the responsibility of the AP (MGPS) to satisfy themself 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.

10.13. The healthcare organisation and/ or the AP (MGPS) may, however, request documentary evidence of competency and training. This will include Competent Person (MGPS) (CP (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.

10.14. The contractor is responsible for ensuring that the staff working on any project are appropriately trained and qualified to carry out the work.

10.15. The contractor should not allow any staff to work unsupervised on a site unless they have received the appropriate training as detailed in Section 7.

10.16. Ideally, the contractor should only employ their own staff to carry out the maintenance services.

10.17. Where the use of subcontractors is unavoidable, the contractor should obtain prior permission from the healthcare organisation to use such staff.

10.18. The contractor should ensure that any subcontractors are competent and have appropriate training and experience.

10.19. The contractor's representative 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 AP (MGPS), as described in Section 7.

10.20. The contractor's representative should not only be familiar with the recommendations of this SHTM but should also have knowledge and experience in the implementation of relevant codes of practice, such as the Pressure Systems Safety Regulations 2000.

10.21. The contractor's representative is responsible for ensuring that only suitably trained and experienced service engineers (CP (MGPS)) who are familiar with this SHTM and the specialist techniques involved are employed on the maintenance contract.

10.22. The service engineers should have received at least the same training as required for a CP (MGPS), as described in Section 7.

10.23. The contractor should maintain a training programme, and the training of each employee should be recorded in a training log.

10.24. The contractor should assign a skill level to each of their staff, and this should be used when selecting the appropriate staff for a particular task.

10.25. The healthcare organisation may request copies of the training log entry of any of the contractor's staff.

10.26. Contractors' staff deemed by the AP (MGPS) to be incompetent for any reason should not be allowed to work on the pipeline.

General work procedures

10.27. The contractor should have made prior arrangements before each visit in order to minimise any disruption. All contractors' staff should report initially to the AP (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 AP (MGPS).

10.28. The AP (MGPS) should ensure that the contractor's staff are familiar with the MGPS at the site before they carry out any PPM work.

10.29. No work should be carried out, including examination of terminal units, unless a permit-to-work has been issued by the AP (MGPS) in accordance with the permit-to-work procedure.

Note 32: It is expected that an AP (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 AP (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.

10.30. While on the premises, the contractor should comply and should ensure that their staff similarly comply with the requirements of all relevant statutory safety legislation, such as the Health and Safety at Work etc Act 1974.

10.31. The contractor should at all times comply with the healthcare organisation's safety policy, a copy of which should be signed by the contractor.

10.32. The contractor should provide their staff with appropriate identification acceptable to the healthcare organisation and displayed at all times.

Note 33: The healthcare organisation may also issue its own identity or other pass that the contractor should display if so requested. These must be returned to the AP (MGPS) on completion of the work.

10.33. The contractor should supply the AP (MGPS) with a method statement (or statements) applicable to the work. The AP (MGPS) will retain this.

10.34. The contractor should supply the AP (MGPS) with a copy of the contractor's health and safety policy. The AP (MGPS) will retain this.

10.35. The healthcare organisation 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 their staff in the requirements of the fire policy, although when working under a permit-to-work it will be the responsibility of the AP (MGPS) to ensure that the CP (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

10.36. To ensure that the maintenance service is being carried out in accordance with the contract, the healthcare organisation should monitor the work and the performance of the contractor.

10.37. The AP (MGPS) should have responsibility for the satisfactory implementation of the maintenance service and for monitoring the maintenance work carried out by the contractor.

Note 34: The AP (MGPS) should ensure that the contractor's staff and performance are checked on a random basis. On a large site, it may be appropriate to carry out a quality inspection at least every six months.

10.38. The AP (MGPS) should arrange site meetings, when necessary, with the contractor's representatives to discuss progress. Meetings will normally be arranged if the healthcare organisation is not satisfied with the level or standard of service, or if changes in contract details are required.

10.39. The contractor's representative should be present at such meetings, together with the service engineers as appropriate.

10.40. The contractor's agreed attendance at progress meetings should form part of the contract.

10.41. 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.

10.42. The AP (MGPS) should ensure that the service engineer has adequately reported any defects or remedial work required before leaving site.

Test equipment

10.43. The contractor should provide all appropriate test equipment, having identified the test equipment appropriate to each task in the method statement.

10.44. It is not the responsibility of the AP (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.

10.45. The test equipment should be constructed and used in accordance with the requirements detailed in Section 13, Part A.

10.46. 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 35: Calibration records should be kept by the contractor and produced for inspection by the AP (MGPS), if requested.

10.47. 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

10.48. The contractor should submit with the tender a general statement on their capability to support the requirements of the healthcare organisation. This should include details of the various resources available to them; 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.

10.49. The contractor should carry out the services specified in the contract on the dates or at the intervals specified in the contract.

10.50. A schedule of minimum tasks to be carried out is given in paragraphs 10.78 - 10.158. This may be modified by individual healthcare organisations, as appropriate, for their particular requirements.

10.51. In addition to the regular maintenance, the contractor should provide service engineers to carry out additional tasks as requested by the AP (MGPS). These tasks may be routine replacement of wearing parts, non-urgent maintenance tasks or emergency call-out tasks.

10.52. For non-urgent tasks, the extent, cost and time, and approximate duration of the work should be agreed between the contractor and the AP (MGPS) and confirmed in writing.

10.53. Before leaving site on completion of the tasks, the contractor should report to the AP (MGPS) to sign off the permit-to-work and to provide any other information regarding additional work required, remedial work, faults found and the like.

10.54. The AP (MGPS) should sign to the effect that the work has been carried out satisfactorily before the contractor leaves site.

10.55. It is the AP (MGPS) responsibility to satisfy themself that the work has been carried out in accordance with the contract.

Emergency call-out procedures

10.56. 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.

10.57. This service should be available 24 hours per day, 365/6 days per year.

10.58. The exact procedure for initiating a call-out will vary with each healthcare organisation. Each healthcare organisation 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.

10.59. Typically, the healthcare organisation should identify the person(s) responsible for contacting the contractor (that is, the AP (MGPS)), shift engineer, duty engineer and the like), the procedure for generating and authorising an official order for the work, and the procedures for obtaining access to the site at all times.

10.60. The contractor should, normally within a maximum of one hour of receiving an emergency call, contact the person nominated in paragraph 10.59. They should ascertain the nature and extent of the problem and provide an estimate of the arrival time of a service engineer on site.

10.61. 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 healthcare organisation. The geographical location of the healthcare organisation, number of the healthcare organisation's Authorised and CP (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.

10.62. 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

10.63. A list of recommended tasks to be carried out at specified frequencies is given in paragraphs 10.78 - 10.158.

10.64. The tasks are listed as generic tasks. The contractor should prepare a method statement for each of the tasks identified.

10.65. The method statement(s) will be applicable to the actual plant and equipment installed on a particular site.

10.66. 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 and the like
- 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

10.67. It should be the responsibility of the healthcare organisation to ensure that access to the plant and systems is available to the contractor.

10.68. The contractor should liaise with the AP (MGPS) to arrange for such access at least one week before the due date of the visit.

10.69. 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 AP (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.

10.70. No member of a contractor's staff should gain access to any part of the MGPS without prior permission of the AP (MGPS) and issue of an appropriate permit-to-work.

Records

10.71. 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
- healthcare organisation order number
- location, number and type of plant/ equipment
- details of work carried out, that is, planned maintenance, breakdown, emergency call-out and the like - 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 AP (MGPS) for the healthcare organisation - on arrival and before departure
    - a representative (for example clinical officer) for the department visited (see paragraph 10.72)

10.72. For each area visited, the work record should be signed by the departmental representative (for example manager, clinical officer, 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 AP (MGPS).

10.73. 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 AP (MGPS), and the log/ record should be kept by the AP (MGPS). A copy will be made available to the contractor for his records, if so requested.

10.74. 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

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

10.76. 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 area valve service unit (AVSU) serving the area.

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

PPM schedules

10.78. 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 SHTM.

10.79. Recommendations for the minimum tasks at the minimum recommended frequency, including particular details of daily and weekly tests, are given in paragraphs 10.85 - 10.158. Daily and weekly tasks are usually carried out by the healthcare organisation; however, the healthcare organisation may wish the contractor to carry out these tasks as an additional contract.

10.80. 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.

10.81. 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.

10.82. 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, or by use of appropriate calibrated equipment (for example, an acoustic camera) 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

10.83. The actual frequency of maintenance routines should be established from the manufacturer's recommendations for the equipment and plant and from recognised maintenance specifications such as 'SFG20'. 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.

10.84. For each of the tasks listed in paragraphs 10.85 - 10.158, 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 AP (MGPS).

Specific maintenance tasks

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

Records

10.86. 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.

10.87. Counters that record the hours of operation of compressors and vacuum pumps are covered in SHTM 02-01 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

10.88. 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

10.89. 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

10.90. 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

10.91. It is not recommended that safety valves are lifted; every safety valve should have a test certificate in accordance with this SHTM. The safety valve should be replaced every five years under a planned replacement procedure.

Note 36: Statutory obligations under the Pressure Systems Safety Regulations (PSSR) 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 reseat, 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

10.92. Full system overhauls may be recommended by equipment manufacturers but are not considered as part of the following PPM schedules. This work will necessitate shutdown of major plant items and provision of gas from reserve manifolds and the like.

Note 37: It will be the responsibility of the AP (MGPS) to organise such work, in consultation with clinical, nursing and pharmaceutical colleagues.

Electrical tests

10.93. Electrical testing should be undertaken in accordance with the current edition of BS 7671 'Requirements for Electrical Installations', including all current amendments and associated guidance documents. Results of these tests should be documented and kept with the appropriate plant history records.

Pipeline and cylinder-connected equipment

10.94. 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) 'Managing Medical Devices Guidance for health and social care organisations'.

10.95. Only competent and qualified staff must carry out maintenance work.

Filters

10.96. 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 38: Further considerations for filters in MGPS:

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

b. anaesthetic gas scavenging system (AGSS) receiving system filters are prone to collecting lint, which blocks the filters and affects performance.

c. the AP (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 (MV) plant. A suitable permit is shown in Appendix D.

10.97. A filter change procedure for vacuum system bacteria filters is given in Appendix D.

10.98. These units should be serviced in accordance with the suppliers' specifications.

Blenders

10.99. Maintenance should be carried out in accordance with the manufacturers' instructions.

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

10.100. 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.

10.101. A record of the type, batch number of desiccant and date of change should be kept.

Note 39: It is essential that the quality of gas from PSA and medical air (MA) compressors is tested at least quarterly, in accordance with the procedures in Appendix K of SHTM 02-01 Part A.

Terminal units

10.102. Terminal units are vulnerable parts of an MGPS and are susceptible to leaks depending on their level of usage and age. Terminal unit maintenance is listed as a quarterly task; the use of acoustic technology greatly assists in undertaking this PPM task efficiently as intrusive works are only required if any leaks are observed and it is a quick unintrusive procedure that provides a digital record of PPM being undertaken.

Daily/ weekly tasks

10.103. It is the responsibility of the AP (MGPS) to organise any necessary daily/ weekly maintenance on the pipeline.

> Note 40: 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 AP (MGPS) will be responsible for devising these tasks.

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

10.105. MGPS daily maintenance tasks:

1. check all alarm panels, manifolds and plant visual indicators for correct function, absent displays or damage
2. if any manifold is observed to be in operation on its 'emergency reserve' bank, replacements for the empty cylinders should be made available immediately
3. check all plant and manifold pressure gauges for abnormal conditions
4. check plant oil levels

10.106. MGPS weekly maintenance tasks:

1. safety notices (SNs) - check that appropriate notices are clearly displayed in all plantrooms and cylinder stores
2. 'no smoking' notices - check that they are clearly displayed
3. discharge points/ vents/ vacuum/ anaesthetic gas scavenging (AGS) - check that warning notices are clearly displayed
4. check that motor guards are in position and in good repair
5. notices warning of automatic start/ stop - check that they are in position and legible
6. check that plantrooms are free from combustible material and with adequate access for maintenance
7. Check that all cylinders are properly stored/ secured and all batch labels are correct and in date

10.107. Specific daily tasks for vacuum insulated evaporator (VIE) plant:

1. check and record the vessel pressure and contents
2. check and record the pressure of the pipeline
3. heck 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 AP (MGPS)

4. ensure that the compound is secured when leaving and that lights have been turned off

10.108. Specific weekly tasks for VIE plant:

1. check mechanical joints for obvious signs of leaks
2. check for mechanical damage
3. check that the vessel(s) is (are) operating at normal working pressures, and record these
4. check that the plant output (pipeline) pressure is at normal, and record this
5. 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
6. record content level(s) of vessel(s)
7. ensure that there is no build-up of rubbish/ flammable material within the vessel compound
8. report all faults to the AP (MGPS)/ gas supplier as necessary

10.109. Specific weekly maintenance tasks for compressed air plant:

1. check compressor motor and plant control panels to ensure there are no alarm conditions
2. check and record hours run for each pump
3. visually check all compressors for security and any sign of oil leakage
4. with compressor stationary, check that oil level is visible halfway up the sight glass. Inform AP (MGPS) if oil level is not correct or appears cloudy
5. manually open discharge valves on after-cooler and receiver drains and leave open for a few seconds, so that airflow cleans the drains internally. Inform AP (MGPS) if more than 0.5 litres of liquid is drawn off
6. operate compressor duty selector switch and ensure correct operation by monitoring while compressor is running on line
7. record running current of duty compressor
8. record compressor cut-in and cut-out levels on compressor control panel gauge
9. ensure all compressors are left in 'auto' mode
10. check dryer control panel to ensure there are no alarm conditions
11. operate dryer selector switch and ensure correct operation by monitoring while compressor is running on line
12. Inform the AP (MGPS) if any faults are recorded

10.110. Specific weekly tasks for vacuum plant:

1. check pump motor and plant control panels to ensure there are no alarm conditions
2. check and record hours run for each pump
3. visually check all pumps for security and any signs of oil leakage

4. ensure vacuum pump oil level is visible between the top and bottom edges of the oil level sight glass. Inform the AP (MGPS) if the oil level is not correct, or oil appears cloudy
5. check bacteria filter and vacuum pump exhaust drainage flasks to ensure no liquid is present. Inform the AP (MGPS) if there is liquid present
6. record vacuum cut-in and cut-out levels on duty pump gauge
7. record running current of duty pump
8. ensure pumps are in 'auto' mode
9. change over duty and stand-by pumps by use of 'duty select' switch, if not automatic
10. inform the AP (MGPS) if any faults are recorded

Routine testing and maintenance of VIEs/ liquid cylinder systems

10.111. Agreement between the healthcare establishment and the medical gas supplier should ensure that the bulk liquid vessel (VIE)/ liquid cylinder system and associated equipment are maintained correctly.

10.112. Records should be kept of design, installation, maintenance and modifications that are carried out by the healthcare facility and/ or the gas supplier.

10.113. 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 10.108), to be carried out by the facilities management (FM) provider, to ensure that the system is operating correctly.

10.114. 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.

10.115. 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.

10.116. The alarm system should be tested regularly in accordance with the documented healthcare facility procedures and based on the risk assessment.

10.117. 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.

10.118. 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)

10.119. 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 AP (MGPS).

Operational test of compressed gas cylinder emergency supply systems

10.120. At a frequency agreed with clinical and nursing colleagues, the AP (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.

10.121. 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.

10.122. All alarm systems must be checked for correct indications following the tests.

10.123. All operational tests should be detailed in the MGPS operational policy.

Note 41: 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 provision/ equipment'

10.124. This should be carried out on a quarterly basis.

10.125. Each emergency inlet provision or equipment should be capable of providing the required gas flow as defined in the informed design process (IDP) (see Section 1, Part A) without excessive pressure drop or leakage. (A minimum pressure of 3.8 bar should be maintained under full flow conditions).

10.126. On an annual basis, the systems and equipment should be examined for damage to hoses and fittings, and components replaced as required.

10.127. 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

10.128. 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.

10.129. MGPS alarms will often be triggered by necessary work on the system, for example, it may be necessary to test pressure switches.

10.130. 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.

10.131. It is essential that all work is covered by an appropriate permit-to-work, as described in Section 4.

Manifold systems - introduction and safety

10.132. Work on automatic manifolds will necessitate maintaining the healthcare facility supply from the associated emergency reserve manifold system (ERM).

10.133. It is essential, therefore, that correct operation of the ERM is confirmed, as in paragraph 10.132, before it is used as the sole means of supply.

10.134. 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.

10.135. Examine the general condition of the manifold, tailpipes and electrical connections before proceeding.

Manual ERMs - general

10.136. The structure of the ERM will vary according to the age and/ or make of the unit.

10.137. 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 14 bar), the other cylinder valve is opened, and the 'empty' cylinder valve is closed. The empty cylinder is then replaced.

10.138. On ERMs fitted with header-isolating valves, both cylinder valves are kept open during normal use, and changeover is affected by use of the high-pressure valves (one being kept open and one closed).

10.139. Many manual ERMs are fitted with only one J-size cylinder per side, although additional cylinders can be added if required.

10.140. 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

10.141. A fully automatic manifold in support of a MA compressor or VIE is generally identical in construction to those manifolds used in primary supply systems. The maintenance procedures detailed in paragraph 10.138 will therefore apply.

10.142. 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

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

10.144. Manual ERM maintenance tasks:

1. ensure that:
    a. when the duty (primary) manifold is running, the reserve (secondary) manifold cylinders are full
    b. all system pressures are normal (that is, line pressure 4 bar, cylinder pressures are correct in accordance with the cylinder data sheet, depending on cylinder supplier and manifold type)
    c. all alarms are showing green ‘normal’ lamps
    d. the manifold is supplying the healthcare facility
2. close the isolating valve on the ERM slowly and confirm that there is no effect on the line pressure to the healthcare facility
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 tailpipe. A minor leak is permissible and likely, but an obvious major leak denotes failure of the tail-pipe NRV. If the latter happens, do not totally detach the tailpipe but instead retighten it and test other tailpipes 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 42: 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
19. the ERM is now ready for use

Automatic manifold maintenance tasks

10.145. 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.

10.146. Relevant staff should be advised of possible alarm indications.

10.147. 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.

10.148. Automatic manifold maintenance tasks:

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 10.144
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 '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
    c. left bank 'running' lamp will extinguish
    d. left bank 'empty' lamp will illuminate
    e. right bank 'running' lamp will illuminate
    f. 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 tailpipes 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:
    a. right bank ‘running’ illuminated
    b. right bank ‘empty’ extinguished
    c. right bank ‘low’ extinguished
    d. left bank ‘running’ extinguished
    e. left bank ‘empty’ illuminated
    f. left bank ‘low’ extinguished
    g. 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 tailpipes 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 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 43: 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 pressure 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.

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

10.149. 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.

10.150. 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.

10.151. A fully automatic manifold, which will come on line automatically in the event of plant failure, is specified in this SHTM, but older systems may not be equipped with this feature. In many instances, only a small manual manifold (for example 2 x 1 J-size) is fitted. This may be able to supply the healthcare facility for a few minutes only. All compressor support manifolds should be left with their isolating valves open.

10.152. 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.

10.153. In all cases, relevant personnel should be advised of possible alarm indications.

10.154. Compressed air plant maintenance tasks:

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:
    a. check running of cooling fans where fitted
    b. record input and output temperatures of oil/ after cooler where fitted
    c. check safety valves/ pressure gauges for condition and leaks (note gauge readings)

   d. examine all drainage traps and their respective manual bypass valves (where fitted), and check for correct operation and opening, replace or repair if necessary
   e. check the condition of all flexible components and associated electrical bonding
   f. check the receiver(s) for general external condition
   g. check the dryer columns for damage/ rust
   h. check all visible electrical components for damage/ overheating

3. isolate one of the compressors and check the following (a ‘plant fault’ alarm will probably be given at this stage, the other compressor(s) should be selected as ‘duty’ plant):
   a. holding down and fixing bolts - replace/ adjust as necessary
   b. anti-vibration mountings bolts - replace/ adjust as necessary
   c. air intakes, filters and silencers - replace/ clean as necessary
   d. motor alignment - adjust as necessary
   e. drive coupling or pulleys and belts - adjust/ replace as necessary
   f. inter/ after-cooler coils/ fans - clean/ replace as necessary
   g. oil levels and oil filter - top up/ change as necessary
   h. motor windings and bearing - 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 healthcare facility
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 44: 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 45: 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. 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 re-pressurised 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.

Some parts of the following procedure may not be relevant, therefore, to a particular model of plant: the manufacturer’s instruction must be followed. Care should be taken 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 re-pressurisation controls where possible

Note 46: 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 47: 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 healthcare facility 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 48: It is not a requirement of this SHTM 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'

10.155. Compressed air plant annual maintenance tasks:

1. check all electrical connections for security and damage
2. check line pressure switch settings with calibrated gauge, where safe to do so
3. check operation of dryer inlet solenoid and outlet NRV
4. check calibration of dryer dew-point sensor
5. 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 item 21 of paragraph 10.154

Central vacuum plant maintenance tasks

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

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

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

10.159. Central vacuum plant maintenance tasks:

1. before isolation of pumps takes place:
    a. check running of cooling fans where appropriate
    b. examine exhaust drainage traps for oil carry-over. Clean out traps where necessary
    c. check the condition of all flexibles and associated electrical bonding
    d. check the receiver(s) for general external condition
    e. check all pressure gauges for correct operation
    f. 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):
    a. holding down and fixing bolts - replace/ adjust as necessary
    b. anti-vibration mountings bolts - replace/ adjust as necessary
    c. exhausts (including labels), filters and silencers - replace/ clean as necessary
    d. motor alignment - adjust as necessary
    e. drive coupling or pulleys and belts - adjust/ replace as necessary
    f. cooling coils/ fans - clean/ replace as necessary
    g. oil levels and oil filter - top up/ change as necessary
    h. 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 49: 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 360mm Hg)

Note 50: 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.

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

10.160. 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

10.161. AGSS maintenance tasks:

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 bearing - clean/ replace as necessary

Terminal units

10.162. In addition to the PPM tasks, a full re-commissioning 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 re-commissioning should be issued to satisfy the Health and Safety Executive (HSE) requirements for a local exhaust ventilation (LEV) system under the Control of Substances Hazardous to Health (COSHH) Regulations 2002. 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.

10.163. 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 51: 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 maintenance tasks

10.164. Alarm 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/ light-emitting diodes (LED) 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 52: 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 shutdown of the system if the pressure switch is connected to the pipeline via a minimum leak fitting.

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

10.165. 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 53: 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

10.166. 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

10.167. General distribution system maintenance tasks:

1. check for damage especially serious abrasion, flattening of pipework and corrosion due to chemical or water leaks
2. check for the absence of, or damage to, pipework protection methods, especially damage to ductwork and sleeving/ mechanical shielding
3. check for security of/ damage to electrical bonding
4. check for leaks - in any area, from fittings, and the like
5. check for damage to, or removal of, fire stopping
6. check for the absence of, or painting over of, exhaust/ blow-down and pipeline identification labels, flow direction arrows, valve box labels, and the like
7. identify any breaches of security to MGPS plantrooms, AVSUs, line valve assemblies (LVA), valves, bulk liquid oxygen (VIE) compounds, and the like
8. check the accuracy of as-fitted drawing, identification markings, labelling, and the like

Note 54: Only sections of pipework visible during normal PPM will be inspected.

AVSUs/ valves (and LVAs where accessible)

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

10.169. 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.

10.170. Accessible LVAs and AVSUs should be examined for there location cleanliness and cleaned as required.

10.171. Accessible LVAs and AVSUs should be checked for their correct labelling and rectified as necessary. They should also be checked for the orientation of on/ off valves for ease of operation. Valve operation can be checked on shut down of all services to a ward/ department.

Pressure reducing sets

10.172. Pressure reducing regulator maintenance tasks:

1. examine the condition of all pressure regulators
2. check the security of safety valve regulator mounting locking devices where fitted
3. test creep regulators for correct settings

Pendant units/ booms

10.173. Pendant units/ booms maintenance tasks:

1. examine the security of fixings/ mountings, freedom of movement (as applicable),labelling and colour-coding of hose assemblies
2. check for any leakage from hose assemblies

Note 55: 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.

3. test the pendant unit/ boom rotation, retraction, braking and the like

Note 56: Hose construction/ repair is a specialist activity. If hose damage is identified, it should be reported immediately to the relevant authority.

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

10.174. 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.

10.175. Terminal unit maintenance tasks:

1. 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
2. repeat above test and, if satisfactory, test the terminal unit for correct flow and pressure drop using a test instrument (see Table 2.10 in SHTM 02-01 Part A for pressures to be achieved at defined terminal unit flow rates under design flow conditions)

Note 57: 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 2.10 in Part A of this SHTM to be used as test criteria.

Appendix A Preparing an operational policy

General

A.1 Appendix B contains the essentials of an operational policy, although this will require expansion and modification to suit individual events.

A.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.

A.3 However, the advice given in these Appendices will help provide a basic policy structure.

Signatories

A.4 It is essential that the policy is acceptable to the Executive Manager, and they should signify this on the policy document.

A.5 Other signatories will be required, principally those personnel involved in the preparation of the policy, or at least members of the Medical Gas Safety Group (MGSG).

Circulation

A.6 The MGSG 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

A.7 A small (A3/ A4) site plan should be drawn up, showing the location of vacuum insulated evaporator (VIE), plantrooms, cylinder stores, main buildings, roads and the like. 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

A.8 There is little point in the medical gas pipeline systems (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.

A.9 Many policies fail to achieve operational usefulness by a simple failure to update basic information such as names and telephone numbers.

A.10 It is important to keep any lists of contact details up to date and, preferably, together in one easily accessible section of the policy (for example as a separate appendix).

Emergencies

A.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.

A.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.

A.13 This section should be compulsory reading for all staff working with the MGPS.

Description of the MGPS

A.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.

A.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.

A.16 For the main policy document, each of the major system components (that is, manifolds, compressors and the like) needs to be treated in separate sections under the following headings:

- security
- communications/ documentation
- emergency actions
- routine operations
- location
- safety
- personnel/ responsibilities

A.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.

A.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.

A.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 and the like
- 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 and the like
- MGPS testing procedures/ responsibilities
- cylinder supply and control procedures
- Control of Substances Hazardous to Health (COSHH) Regulations 2002-related statements (for example anaesthetics/ anaesthetic gas scavenging systems (AGSS))
- 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 and the like 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 continuous positive airway pressure (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 and the like
- normal and emergency procedures for the interruption of a gas supply

Emergency actions

A.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
- fire

A.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

A.22 communication channels in the event of an emergency:

- fire officer/ brigade
- estates department
- pharmacy
- portering staff
- administration/ press officer
- nursing/ clinical

Appendix B Sample operational policy

B.1 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 bold blue text**.

NHS Body/ organisation

Operational policy and procedures for the management of medical gas pipeline systems

Figure B.1 - Operational policy document control table

Preparation date:			
Review date:			
Issue no.:			
This copy no.:			
Healthcare facility publication reference no.:			
This copy belongs to:		Tel. no.:	
Distribution list:		See Annex 2	

General policy statements

B.2 This policy addresses the provision of a medical gas pipeline system (MGPS) in **[name of site]**.

B.3 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.

B.4 **[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

B.5 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) (AP (MGPS)) or covered by this policy).

B.6 It applies throughout the **[premises]** to all fixed MGPS and (list of plant and areas, for example Dental or Sterile Services Departments (SSD) and the like where MGPS may be installed).

B.7 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.

B.8 MGPS terminal units define the limits of Estates' [or other organisation] responsibility in this policy.

B.9 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.

B.10 **[If medical equipment is to be included, this will have to be mentioned here]**.

B.11 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 (MA) 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 AP (MGPS) must be completed.

Responsibilities

Executive Manager

B.12 Ultimate management responsibility for the MGPS rests with the **[premises]'s** Executive Manager. The Executive Manager **[. . .]** herein delegates written appointment of Authorised Persons (MGPS) to **[name]**. The executive manager **[. . .]** herein delegates day-to-day management responsibility for the MGPS to **[name - usually Co-ordinating/ Authorised Person (MGPS)]**.

Authorising Engineer

B.13 The duties and responsibilities of the Authorising Engineer (AE) 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 AP (MGPS) have satisfactorily completed an appropriate training course

- to ensure that all AP (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
- in accordance with Scottish Health Technical Memorandum (SHTM) 00 act as an independent professional adviser to the healthcare organisation
- provide technical, design and contractual advice on all new works where required
- provide an annual audit to the senior executive with assigned MGPS responsibilities

B.14 **[Add additional duties if required]**.

Authorised Person (MGPS)

B.15 **[Number]** AP(s) (MGPS) are required for **[premises]** and will be based in **[premises]**. The AP(s) (MGPS) are listed in Annex 3: Contacts. The AP (MGPS) assume effective responsibility for the day-to-day management and maintenance of the MGPS. The duties and responsibilities of AP (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) (CP (MGPS)) for all servicing, repair, alteration and extension work carried out on the existing MGPS
- to supervise the work carried out by CP (MGPS) and monitor the standard of that work (a register of CP (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 Clinical Officers, the Quality Controller (MGPS) (QC (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 organize 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)

B.16 All CP (MGPS) are craft persons, employed by **[company name(s)]** (entry here will depend on employer, that is direct labour and/ or contractor. If both are employed, the term CP (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 CP (MGPS).

B.17 All CP (MGPS) shall be registered to British Standard (BS) European Standard (EN) International Standard (ISO) 9001/ BS EN ISO 13485, with clearly defined registration criteria.

B.18 The duties and responsibilities of CP (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 AP (MGPS) in accordance with the permit-to-work system and SHTM 02-01
- to perform engineering tests appropriate to all work carried out and inform the AP (MGPS) of all test results
- to carry out all work in accordance with the **[premises]** health and safety policy

Quality Controller (MGPS)

B.19 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.

B.20 The AP (MGPS) will be responsible for liaising with the QC (MGPS) and organising attendance as required.

B.21 The duties and responsibilities of the QC (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 terminal units)
- to liaise with the AP (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 QC (MGPS)

B.22 They 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
- whether pharmacy control is from another site

B.23 There will also be different insertions if the QC (MGPS) function is provided from another site within the healthcare organisation and/ or the QC (MGPS) is from an independent organisation. **[In the latter instance, the exact terms of reference for appointment and call-out and the like 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:

B.24 **[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 European Pharmacopoeia (Ph. Eur.) requirements
- ensure that other gases and gas mixtures comply with manufacturers' product licenses

Designated Clinical Officer (DCO)

B.25 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 are DCO?

B.26 If the former applies, a statement such as the following should be included:

B.27 '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 DCO will not be used.'

B.28 The duties and responsibilities of the DCO are:
This section should contain information on:

- who the defined person is and a statement of their responsibility to liaise with the AP (MGPS)
- their scope of responsibility for giving permission to interrupt supplies

- any requirement to employ a DCO 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 Staff

B.29 Designated staff **[usually a porter but may be different in the private sector]** with particular responsibilities for medical gases. They will have undergone specialist training in the identification and safe handling and storage of medical gas cylinders, including relevant manual handling training.

B.30 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 tailpipes
- identify, and remove from service, faulty (for example, 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

B.31 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 Safety Group

B.32 A Medical Gas Safety Group (MGSG) shall consist of the Co-ordinating AP (MGPS), the **[premises]**, nominated DCO, the portering manager, the Quality Controller (MGPS), Chief Pharmacist, Finance representative, AE (MGPS).

B.33 Other signatories to this document shall also be invited to join the group when appropriate.

MGPS operational policy review

B.34 The MGPS operational policy should be reviewed by the MGSG **[frequency]**; the chair of the MGSG **[or other nominated chair]** shall convene the review meeting and be responsible for writing and distributing the minutes of the meeting. The MGSG shall report to the Chief Executive/ General Manager.

MGPS record drawings and documentation

B.35 The AP (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
- SHTM 02 and all latest editions of any associated supplements
- 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

B.36 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

B.37 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.

B.38 MGPS training at the **[premises]** for all **[usually estates]** staff is administered by **[name/ department]**.

B.39 A record of those trained is kept in the **[department]**.

B.40 It is the duty of departmental managers to ensure that all staff working with the MGPS are appropriately trained.

B.41 The AP (MGPS) may request training records of contractors' staff.

B.42 Training on MGPS will be provided as follows:

B.43 **[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

B.44 [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].

B.45 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.

B.46 As an example, a compressed MA 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

B.47 Has the obvious advantage of all information on air plant being presented on one page.

B.48 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

B.49 A **[make]** duplex MA compressor/ dryer unit supplies medical compressed air to the **[premises].**

B.50 It is housed in the **[location]** and provides both medical and surgical air (SA).

B.51 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

B.52 The compressor unit and its emergency supply manifold are located in locked rooms. CP (MGPS) should be allowed, on proof of identify, to gain access by signing out the relevant keys from **[usually Estates]**.

Signage

B.53 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

B.54 A **[make]** duplex MA compressor/ dryer unit supplies medical compressed air to the **[premises]**.

B.55 It is housed in the **[location]** and provides both MA and SA.

B.56 A manual gas 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

B.57 The compressor unit and its emergency supply manifold are located in locked rooms. CP (MGPS) should be allowed, on proof of identify, to gain access by signing out the relevant keys from **[usually Estates]**.

Security - key-holders

B.58 Keys for these rooms are available from **[location]** or by contacting **[name]**. See Annex 3: Contacts in Appendix B for list of contacts.

Emergency contact

B.59 In an emergency, see Annex 3: Contacts in Appendix B for contact details.

Signage

B.60 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

B.61 [Other plant will be described as in (a) or (b) above and will include separate descriptions for each manifold, compressor and the like.

B.62 Anaesthetic gas scavenging systems (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.

B.63 Although alarm systems will be described here, actual responses to alarm indications are better covered in other sections of the policy (see below).

B.64 If the AP (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

B.65 [Each storage area (main, ready-to-use and the like) 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 Section 8.]

Area valve service units (AVSUs)

Summary

B.66 Locked boxes containing isolating valves in enclosures with breakable glass fronts (AVSUs) are provided at the entrance to wards and departments.

B.67 These valves provide facilities for both routine and emergency isolation of gas supplies.

B.68 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.

B.69 [Non - non-interchangeable screw thread (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 line valve assemblies

B.70 Pipeline valves (called lockable line valve assemblies (LLVAs)) in ducts, risers, ceiling spaces and the like shall be locked in the normal operating position.

B.71 Pipeline valves will normally be left unlocked if they are sited in a locked plantroom. **[Usually Estates]** will hold keys for these valves.

Access

B.72 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 line valve assemblies (LVAs) under control of a permit-to-work.

B.73 The key cabinet contains a list identifying all AVSUs and locked LVAs, with corresponding key numbers.

Key-holders

B.74 Key-holders are listed in Annex 3: Contacts.

B.75 In the event of an emergency, access to the valve boxes and AVSUs may be gained by smashing the breakable glass fronts.

B.76 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.

B.77 [At this point, a diagram/ photograph of an area valve service unit (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 and the like].

Routine procedures

The MGPS permit-to-work system

B.78 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.

B.79 It is the policy of **[healthcare organisation/ premises/ organisation]** that, with the knowledge and permission of the AP (MGPS) , a permit must be raised before any work (except changing of manifold cylinders **[add vacuum insulated evaporator (VIE) refilling, QC testing of medical/ surgical air and the like 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.

B.80 Granting of a permit-to-work and the way in which the work is carried out must follow the directions of SHTM 02-01 unless otherwise defined in this policy.

B.81 Responsibilities for signing a permit-to-work lie with the DCOs in each department.

B.82 Officers should ensure that colleagues are advised of the interruption to the gas supply and its estimated duration.

B.83 Officers should also ensure (via **[usually Estates]**) that all affected terminal units are appropriately labelled.

Planned interruption

B.84 A planned interruption will be needed for repair, extension or modification to the existing MGPS. An AP (MGPS) shall supervise any planned interruption in strict accordance with the permit-to-work system in SHTM 02-01. The QC (MGPS) shall be involved in any planned interruption from the initial planning stage.

B.85 The AP (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

B.86 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.

B.87 Cross-connection, performance, identity and quality tests shall be required before the MGPS is taken back into use.

B.88 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.

B.89 In such events, an AP (MGPS) must ensure that key personnel for each ward or department are informed; if necessary, they could hold a site meeting.

B.90 The QC (MGPS) should be included in any discussions that may lead to an interruption of the MGPS.

B.91 Two weeks before the planned interruption, the AP (MGPS) shall liaise in person with the DCOs) of the ward(s) or department(s) concerned.

B.92 At the same time, the AP (MGPS) will complete part 1 of the permit-to-work form.

B.93 The DCO(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.

B.94 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 DCO(s).

B.95 A copy of this memorandum will be sent to the ward(s) or department(s) concerned. A further memorandum, requesting the services of a QC (MGPS) and detailing the requirements for portable cylinders, shall be sent to the pharmacy department **[or other QC organisation]**.

B.96 It is the responsibility of the AP (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]**).

B.97 Any additional portable vacuum units to be supplied are the responsibilities of the wards/departments concerned.

B.98 The AP (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).

B.99 Work shall only commence when the DCO(s) 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.

B.100 The AP (MGPS) will then supervise isolation of the AVSU(s) by the CP (MGPS) after:

- confirming isolation details by consultation with the CP (MGPS)
- examining the sketch on the fourth sheet of the permit and any additional drawings (if available)

B.101 Once the system(s) has/ have been isolated and depressurised, the CP (MGPS) will sign:

- part 2
- (together with the AP (MGPS)) the fourth sheet of the permit-to-work form, and then commence work

B.102 The CP (MGPS) will sign part 3 of the permit to certify that work has been completed and contact the AP (MGPS) so that the installation may be examined and tested.

B.103 Depending on the extent of high hazard work, the AP (MGPS) will determine and carry out, with the assistance of the CP (MGPS), the necessary tests and examination of the system(s) in accordance with Section 13 'Validation and verification' in Part A of SHTM 02-01.

B.104 When these tests have been completed satisfactorily, the AP (MGPS) will initial the relevant spaces and sign part 3 of the permit.

B.105 The QC (MGPS), with the assistance of the AP (MGPS), will carry out identity and quality tests on the system(s) in accordance with Section 13 'Validation and verification' in Part A of SHTM 02-01.

B.106 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.

B.107 The QC (MGPS) will receive the pink copy of the permit-to-work form from the AP (MGPS).

Note 58: 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 AP (MGPS) and the CP (MGPS)) of the white copy may be issued to the CP (MGPS) on request.

B.108 The DCO(s) will accept the system(s) back into service by signing part 5 of the permit and will undertake to notify their colleagues that the system is fit for use.

Low hazard work

B.109 Any work on the MGPS which will not introduce any hazard of cross-connection or pollution will be classified as low hazard work.

B.110 A performance test will be required before the MGPS is taken back into use.

B.111 If there is any doubt as to the hazard level classification of a particular permit-to-work, advice should be sought from the Co-ordinating AP (MGPS).

B.112 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.

B.113 This type of work is usually carried out at short notice because of the need for minimum disruption to patient care. The AP (MGPS) may have to arrange a portable cylinder or vacuum unit so that the terminal unit can be taken out of service.

B.114 The AP (MGPS) will fill out the relevant section of part 1 and the fourth sheet of the permit-to-work form. The AP (MGPS) will liaise with, and fully brief, the DCO of the ward/ department, who will then sign part 1, if required.

B.115 The AP (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 CP (MGPS) will sign:

- part 2
- (together with the AP (MGPS)) the fourth sheet of the permit-to-work form, and then commence work

B.116 The CP (MGPS) will sign part 3 of the permit to certify that the work has been completed and contact the AP (MGPS) for the installation to be examined and tested.

B.117 The CP (MGPS), with the assistance of the AP (MGPS), if necessary, will carry out flow, pressure drop, mechanical function and gas-specificity tests on the serviced terminal unit(s).

B.118 Other equipment function tests, for example on plant, will be made to the satisfaction of the AP (MGPS).

B.119 The AP (MGPS) and CP (MGPS) will initial the relevant spaces and sign part 3 of the permit.

B.120 When satisfied with the test results, the AP (MGPS) will sign part 4 of the permit or indicate that further work is necessary.

B.121 The DCO of the ward or department will accept the MGPS back into service by signing part 5 of the permit and will undertake to notify their colleagues that the system is fit for use or requires further work.

Actions in the event of a medical gas alarm

B.122 [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].

B.123 This may become cumbersome if a wide variety of panels are installed, but this is not generally the case.

B.124 Again, laminated sketches, similar to those in the policy (and shown in Example 1) can be posted adjacent to the relevant panel(s).

B.125 The diagrams below show the actions that should be taken at each level of alarm.

B.126 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.

B.127 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.

Note 59: Disabling the alarm system, other than when due authorisation has been obtained from an AP (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 CP (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

B.128 It is the responsibility of the AP (MGPS) to ensure that a procedure for each alarm indication is displayed next to the respective central alarm panel.

Note 60: 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

B.129 This section is copied (amended where appropriate) directly from Section 8.

B.130 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 (ERM) (for example leaving one (cylinder) valve open and one closed), delivery of gases to wards, stores and the like, delivery of liquid oxygen.

B.131 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.

B.132 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 and the like

B.133 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.

B.134 No isolation should take place without full liaison between the AP (MGPS) and all other disciplines.

B.135 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]**.

B.136 Attempts should be made to reduce gas consumption during the work.

Generator operation on mains failure

B.137 [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].

B.138 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.

B.139 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.

B.140 Additionally, it must be remembered that failure of generator and mains supplies simultaneously will result in failure of the central medical vacuum (MV) system.

B.141 It is important that clinical/ nursing staff are aware of this risk to the MV system and any patients using it.

B.142 All relevant staff must undertake training in the use of emergency vacuum equipment.

B.143 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.

B.144 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 MA).

B.145 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.

B.146 To locate portable vacuum units, call **[department]**.

B.147 Failure of both mains and emergency generator supplies will also mean that the MA compressors will not function.

B.148 Emergency supplies of MA 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.

B.149 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

B.150 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.

B.151 The **[premises]** fire officer should be consulted on the use of toys in oxygen tents, and a notice worded ‘only toys, cosmetics and the like approved by the fire officer are allowed in this area’ must be posted at the entrance to the treatment area.

B.152 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.

B.153 [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

B.154 The sample text below will probably require considerable amendment to suit particular circumstances. The title also refers to ERMs such as those attached to plant.

B.155 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.

B.156 It will be necessary to describe the location and emergency operating procedures for all the types of manifold on the premises.

General statement

B.157 ERMs are attached to all medical gas systems.

Oxygen system

B.158 In the event of failure of the primary oxygen supply source, the secondary (cylinder manifold) supply source will automatically provide the **[premises]** with gas.

B.159 The manifold supply will change banks automatically but will require cylinder replacement as a bank empties.

B.160 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.

B.161 Measures to reduce gas consumption may also need to be taken.

B.162 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

B.163 The automatic manifold supporting the MA plant will come on line automatically and will change banks automatically.

B.164 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 nitrous oxide/oxygen mixture

B.165 The nitrous oxide and nitrous oxide/oxygen mixture automatic manifold systems are fitted with manually operated ERMs

B.166 These supply gas in the event of failure of, or loss of gas from, the main manifold.

B.167 The ERM will come on line automatically; it will not be necessary to open the ERM main isolating valve to ensure that gas supply is maintained.

B.168 When in use, it will not change from left to right cylinder banks automatically.

B.169 **[Usually Estates]** and **[usually portering]** staff should be fully trained in the operation of the ERM.

B.170 Detailed instructions identifying which valves to turn and in which order shall be posted adjacent to each ERM.

B.171 Due to the limited capacity of the ERM, it is essential that the pressure in the cylinders be monitored continuously while it is in use.

B.172 Manual changeover from an almost empty to a full cylinder will be required.

B.173 A full one must then replace the empty gas cylinder.

B.174 It is the duty of **[usually portering]** to ensure that sufficient gas cylinders are available to maintain the gas supply.

B.175 The MV system has no emergency reserve manifold system. Failure of the plant for any reason will result in total failure of the vacuum service.

B.176 [The following emergencies are offered as samples only. Local circumstances will dictate the amount of alteration required].

Emergency cylinder ordering procedure

B.177 [This tends to be very site-specific. Hence a sample is included here without further comment].

Note 61: The pharmacy department will perform routine cylinder ordering based on required stock levels and weekly use. Portering or suitably trained healthcare staff will check stocks weekly and report any deficiencies to pharmacy.

B.178 For emergency ordering, the following procedure should be followed:

- pharmacy will telephone the emergency number of the medical gas supplier (see Annex 3: Contacts)
- 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.

B.179 The note should then be passed to pharmacy.

Failure of mains electricity supply

B.180 [It will be necessary to describe the consequences of failure of both mains and essential supplies in this section].

B.181 In the event of an electricity failure, medical gas supplies should be maintained by the emergency generator system (the 'essential' supply).

B.182 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.

B.183 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 MA ERM
- nitrous oxide and nitrous oxide/oxygen mixture manifolds will continue to supply gas
- alarm panels will display a 'system failure' red warning light and give an audible alarm

B.184 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.

B.185 In any of these events:

- the AP (MGPS) will be informed of the situation via the nursing staff/ telephonist

- suitably trained healthcare staff, portering and estates will arrange for staff to monitor manifold gas consumption, replacing empty cylinders as necessary until the electricity supply is restored
- the AP (MGPS) will arrange emergency cylinder/ regulator supplies as necessary
- the AP (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

B.186 In these events:

- the duty porter and the AP (MGPS) will be contacted by the telephonist/ nurse in charge
- 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 AP (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 AP (MGPS) will arrange for repairs to the system(s) affected to be carried out under the permit-to-work system

B.187 [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

B.188 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 AP (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 AP (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
- healthcare 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 AP (MGPS) will liaise with the CP (MGPS) to complete emergency repairs needed to reinstate the gas supply, using the permit-to-work system
- when the supply is fully restored, the AP (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

B.189 In situations where it is envisaged that there will be long-term loss of oxygen or MA service, the duty senior manager will liaise with clinical colleagues, including the senior nurse manager, the medical director and the AP (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

B.190 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.

B.191 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.

B.192 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.

B.193 In such an event, the fault should be treated as a complete gas failure to that area and the actions described above taken immediately.

B.194 It is very important that, if such an incident occurs, the telephonist advises all departments of the problem, especially critical care areas.

B.195 Contamination of the MV 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.

B.196 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).

B.197 It is the responsibility of the CP (MGPS) to change the filter in accordance with the procedure described in SHTM 02-01 and any additional advice from the infection control officer.

B.198 If the contamination is due to system misuse, the AP (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.

B.199 Decontamination of pipework (if necessary) should be carried out in accordance with the procedure described in SHTM 02-01 before filters are changed.

Failure of an AGSS

B.200 Failure of an AGSS results in spillage of gaseous/ vaporised anaesthetic agents into the area of use of the system.

B.201 In theatres, it is likely that staff exposure to the spilled gases will exceed the Control of Substances Hazardous to Health (COSHH) Regulations 2002 recommendations for exposure when working in the area for extended periods, even though ventilation rates are high.

B.202 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.

B.203 The AP (MGPS) and the theatre manager will be informed of the failure by **[usually the theatre staff]**, and all attempts should be made to reduce staff exposure, if operations continue with a failed system.

B.204 When repairs have been completed (under a permit-to-work signed by the theatre nurse manager, (or 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

B.205 Local alarms are designed to indicate when system pressure(s) is/ are outside the normal operating range.

B.206 Excessively high or low pressures may cause medical equipment to malfunction.

B.207 The nurse in charge should report all instances of local alarm operation to the telephonist.

Emergency isolation of a gas supply

B.208 [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

B.209 Procedures in accordance with the **[premises]** fire policy should be followed in the event of a fire involving, or likely to involve, the MGPS.

B.210 During a fire, the senior brigade officer will assume full control of the area(s) affected.

Note 62: 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 Co-ordinating Authorised Person (MGPS) for medical gas systems within the **[premises]** is **[name]**.

Figure B.2 – Policy signatories

This policy is accepted by:		
Executive Manager		
Name: ….....	Signature:	Date: .....
Co-ordinating Authorised Person (MGPS)		
Name: ….....	Signature:	Date: .....
Senior/ QC (MGPS)		
Name: ….....	Signature:	Date: .....
Designated Clinical Officer		
Name: ….....	Signature:	Date: .....
Clinical Risk Manager		
Name: ….....	Signature:	Date: .....
Portering Manager		
Name: ….....	Signature:	Date: .....
Infection Control Officer		
Name: ….....	Signature:	Date: .....
Fire/ Safety Officer		
Name: ….....	Signature:	Date: .....
Authorising Engineer (MGPS)		
Name……..	Signature…….…..	Date ……..

Assistance with the interpretation of this policy, or additional copies, can be obtained by contacting **[name]**.

Annex 2: Policy circulation list

The policy circulation list for the MGPS operational policy should be included here

Annex 3: Contacts

Figure B.3 - MGPS contacts

Authorised Persons (MGPS)

Name	Contact number

Competent Persons (MGPS)

Name	Contact number

Designated Clinical Officers (MGPS)

Name	Title	Contact number

Other important telephone numbers

Name	Contact number	Out-of-hours contact number
Portering		
Quality Controller (MGPS)		
Gas supplier(s)		
Risk Manager (emergency)		

Keyholders

Name	Contact number	Out-of-hours contact number

Annex 4: Contractors

B.211 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.

B.212 In the case of gas suppliers, it would be useful to note the cylinder and liquid supplies account details to facilitate emergency deliveries.

B.213 Contact names and positions should be included wherever possible.

B.214 Additional statements pertaining to training and accreditation of contractors can also be included here. This is best copied from Section 10.

B.215 Responsibility for providing as-fitted drawings is also described in Section 10 and this could also be added here.

Annex 5: Statutory requirements relevant to MGPS

B.216 [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 (RIDDOR) 1995
- Control of Substances Hazardous to Health (COSHH) Regulations 2002
- Pressure Equipment Regulations 1999
- Pressure Systems Safety Regulations (PSSR) 2000
- Dangerous Substances and Explosive Atmospheres Regulations 2002
- 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

- SHTM 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'
- European Pharmacopoeia (Ph.Eur) 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

C.1 There are essentially three parts to a maintenance contract:

- 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 [ ] (healthcare organisation premises).
- The Contractor is required to undertake all works as described in this specification'
- 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
- 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

C.2 Contract for the maintenance of MGPS installed in [ ] (healthcare organisation premises).

General

C.3 The enclosed plan shows the site for which this specification is applicable. Not all buildings on this site contain medical gases.

C.4 Medical gas pipelines fitted on this site deliver:

- oxygen
- nitrous oxide
- nitrous oxide/oxygen mixture
- medical air (MA) 400 kPa (medical air (4bar) (MA4))
- surgical air (SA) 700 kPa (surgical air (7bar) (SA7))
- medical vacuum (MV)
- anaesthetic gas scavenging systems (AGSS)

C.5 The Contractor will be required to complete and sign [ ], a copy of which is attached to this specification.

C.6 This specification is subject to [ ] healthcare organisation'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.

C.7 Contract period. This maintenance contract will be for a [ ] calendar year period starting from [ ].

C.8 This may be extended by [ ] healthcare organisation by a further [ ] years to a maximum of [ ] years.

C.9 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 C.13. 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.

C.10 Contract cancellation. At the end of the first [ ] months, either party giving [ ] months' notice in writing may cancel the contract.

C.11 Failure by the Contractor to meet the requirements set out under 'particular specification' below will result in termination of the contract by [ ] healthcare organisation, by the serving of [ ] months' notice at any time during the contract period.

C.12 Technical standards. All works undertaken by the Contractor must comply with SHTM 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 [ ] (healthcare organisation).

C.13 Service visit frequency. Maintenance visits by the Contractor will take place on a [ ] monthly basis on the following dates: [ ]

C.14 Work must commence within [ ] days of these dates and must be completed within [ ] day [ ] of these dates.

C.15 Emergency interruptions. With the exception of unforeseen emergencies, which will be monitored by [ ] healthcare organisation estates services, each contracted maintenance visit as described in the particular schedule should be undertaken as one continuous visit to site.

C.16 Contractor's personnel. The Contractor should employ maintenance staff performing the work as described.

C.17 No subcontracted staff will be employed on [ ] (healthcare organisation's) premises without the express permission of estates services.

C.18 It is the duty of the Contractor to ensure the competence of personnel undertaking this work.

C.19 [ ] (healthcare organisation) reserves the right to request the removal of any member of the Contractor's staff who is deemed by [ ] (healthcare organisation) to be unsuitable to be working on the healthcare organisation's premises. No reason need be given for this decision.

Particular specification

C.20 This particular specification relates to the MGPS as described in C.3 and C.4 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/ SA compressors and vacuum plant
- all AGSS

C.21 The Contractor is to include for all sundry items regardless of any maintenance frequency required as part of the routine maintenance.

C.22 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) (AP (MGPS)) to arrange convenient visiting times.

C.23 Call-outs for repairs during normal working hours must be quoted accordingly.

Exclusions. The contract price will not include:

- work required to be undertaken as a result of damage to the system, unless caused by the contractor
- call-outs for repairs outside normal working hours
- routine maintenance work, where this cannot be accommodated within normal working hours
- materials, other than those identified in paragraph C.21

C.24 The Contractor should provide an emergency call-out facility for the request of work outside normal working hours.

C.25 The call-out response time should be a maximum of [ ] hours at all times.

C.26 The Contractor's representative should report to the AP (MGPS) on each arrival on and departure from site.

C.27 All Contractor's staff must wear personal identity badges provided by the Contractor and visitors' badges provided by [ ] (healthcare organisation) at all times they are on the healthcare organisation's property.

C.28 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 AP (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 AP (MGPS).

C.29 At the end of each service visit the Contractor should provide the AP (MGPS) with a report detailing the work.

C.30 This report should be signed by the Contractor's representative undertaking the work and must be submitted to the AP (MGPS) within [ ] days of completion of the visit.

C.31 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.

C.32 In the case of terminal units, such labels will be fixed next to the valve box controlling these units.

C.33 Minor works. This contract applies only to the routine maintenance of the medical gas systems within [ ] (healthcare organisation). On occasion, the contractor may be required to submit tenders for work associated with minor alterations and improvements to these systems.

C.34 This contract does not imply exclusivity of the contractor for undertaking these works. [ ] (healthcare organisation) will seek competitive quotations for each piece of work.

C.35 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 and the like.

C.36 Capability statement. The contractor should submit (with the quotation) a general statement on their ability to support the requirements of [ ] (healthcare organisation).

C.37 This should include details of various resources available to the contractor, number of staff, competence levels, emergency support provision and the like.

C.38 Documentation. The contractor should provide:

- details of any other similar contracts being undertaken
- a copy of the contractor's registration certificate under British Standard (BS) European Standard (EN) International Standard (ISO) 9001/ BS EN ISO 13485, with relevant scope for maintenance of medical gas systems defined
- copies of calibration certificates for all test equipment used in this work
- a list of Competent Persons (MGPS) (CP (MGPS)) who may be employed during this contract
- copies of the training records of the above CP (MGPS)
- a copy of the Contractor's health and safety policy
- a copy of the Contractor's method statement, including any relevant risk assessments
- copies of any relevant test/ record sheets used by the Contractor, including records of each service visit

C.39 [ ] (healthcare organisation) will provide the Contractor with additional up to date as-fitted drawings when necessary.

Schedule of work

C.40 Plant/ systems on which the work is required (list).

C.41 (Detail of the work to be defined here, with due regard to manufacturer's data and the maintenance schedules detailed in this SHTM).

Appendix D Work on medical vacuum and anaesthetic gas scavenging systems

Work on medical vacuum (MV) systems

D.1 This Appendix contains information on the following topics related to work on a medical vacuum (MV) system:

- working on MV terminal units, plant and pipelines, including pipeline removal
- changing bacteria filters on MV plant
- cleaning procedures for MV systems contaminated with aspirated blood products and the like

D.2 It should be noted that these procedures do not apply to any work on high-risk MV systems that may be installed in infectious disease units. This Scottish Health Technical Memorandum (SHTM) does not recommend the use of piped MV 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 MV terminal units, plant and pipelines

D.3 The basic hygiene procedures outlined in this Appendix will suffice for most work on MV systems, including removal of redundant pipework.

D.4 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.

D.5 Waste oil and condensate from vacuum pumps and exhaust traps should be disposed of as ‘hazardous waste’ in accordance with healthcare facility procedures.

Changing bacteria filters on MV plant

D.6 Before carrying out the work, advice should be sought from the user on any toxic or infectious materials that may have entered the system.

D.7 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.

D.8 All staff, including contractors, should observe local safety procedures as set out in the healthcare organisation's safety policy.

Note 63: Use of additional permits: The medical gas pipeline system (MGPS) permit-to-work in this SHTM can be used for general work on MV systems. However, previous editions of this SHTM 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

D.9 Two heavy-duty polythene bags will be required.

D.10 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

D.11 Disposable overshoes should be worn if required by the healthcare facility.

Filter and protective clothing disposal

D.12 The used filter is placed directly into a heavy-duty polythene bag, which is then sealed.

D.13 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'.

D.14 The staff carrying out the filter change should notify the waste disposal department and/ or the Authorised Person (MGPS) (AP(MGPS)), as appropriate, so that bags can be collected and disposed of.

D.15 A sample permit, for use with the MGPS permit, a standard operating procedure (SOP) for filter changes and a filter change procedure suitable for posting on/ near vacuum plant are shown on the following pages.

Figure D.1 - Bacteria filter replacement - Central MV plant permit-to-work example

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)

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D.16 An example of a SOP for changing bacterial filters on MV plant is listed below:

1. the MV system must be considered potentially contaminated, and you must take the precautions listed below
2. if you observe any suspicious contaminant, such as mucus or blood, stop work immediately and report the situation to the AP (MGPS)
3. biological contamination may appear crystalline or organic. Do not be deceived by appearance; treat all foreign material as a possible hazard
4. do not commence any work on an MV system suspected of contamination without authorisation and guidance from the AP (MGPS)
5. do not eat or smoke when working on MV systems or components
6. 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
7. do wear the waterproof gloves provided and ensure that they remain intact throughout all work stages
8. do wear standard issue overalls and ensure that they remain fully buttoned
9. do wear eye protection, the face mask and disposable plastic apron provided
10. do wear all protective clothing throughout all work stages
11. do take care not to cut yourself. If you do happen to cut yourself, carry out the following procedures:
    a. if a glove is punctured, remove glove
    b. allow wound to bleed freely
    c. the contaminated area should be washed gently under running water and not scrubbed
    d. inform the AP (MGPS) of the incident immediately
    e. seek medical advice on appropriate action, for example the need to administer hepatitis B vaccine
    f. report the incident in accordance with local or company rules
12. do dispose of all removed infected material and oil in accordance with healthcare facility procedures, for example sealed within a bag marked ‘contaminated’ and entrusted to the hospital authorities for safe disposal
13. do request guidance from the AP (MGPS) if in doubt about disposal procedures
14. do not remove contaminated materials from site
15. do not dispose of potentially contaminated material in ordinary rubbish bins
16. do not place contaminated tools or equipment into your toolbox
17. 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
18. Potentially contaminated material must not be blown through an open-ended pipeline

D.17 The bacteria filter change is detailed below (it is recommended that this procedure be affixed on or near the MV 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 AP (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. Filter elements cannot be cleaned or re-used. Dispose of in accordance with healthcare facility 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. 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

D.18 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 carryover.

D.19 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.

D.20 Contamination of the MV distribution system may result, however, if one or more of these features is omitted or compromised in some way.

D.21 Repetitive induction of fluids can cause a blockage of the pipeline as transported and dissolved solids dry out.

D.22 It is important that the AP (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.

D.23 Removal of system contaminants requires the use of a detergent/ disinfectant solution, which is aspirated via terminal units/ non-interchangeable screw thread (NIST) connectors. Savlon or Teepol can be used.

D.24 Satisfactory results have been obtained by using Savlon in hot water, with an appropriate quantity of sodium dichloroisocyanurate sterilizing tablets added.

D.25 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 area valve service unit (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 SHTM.

D.26 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.

D.27 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).

D.28 Procedure for MV system decontamination using the system vacuum:

- AP (MGPS) to be advised of incident
- AP (MGPS) arranges permit-to-work for taking other downstream terminal units out of service if possible
- establish, in consultation with surgical or clinical practitioners, the possible nature and volume of the contaminant
- consult the infection control officer to ascertain the level of microbiological hazard, including the pathogenicity and persistence of any infectious agents
- from a study of the as-fitted drawings, identify any downstream terminal units that may be flooded during the cleaning process
- a solution of 1% Teepol or Savlon plus sodium dichloroisocyanurate in about 10 litres of hot water should be prepared
- aspirate 1 litres of solution through the terminal unit immediately upstream of the contaminated unit and leave with a low flow via suction controller
- aspirate 5 litres of solution via the contaminated terminal and leave with low flow
- aspirate 0.5 litres through each of the next ten or so units and leave with low flow
- check other downstream terminal units for presence of solution. Where found, repeat the procedure
- repeat the whole procedure using clean hot water

- take the system back into use
- check plant filters for evidence of fluid
- where present, change the bacteria filters (see procedure)
- monitor the system for a few days, with vacuum control units fitted, for evidence of liquid

D.29 Procedure for MV system decontamination using a fluid pump:

- AP (MGPS) to be advised of incident
- AP (MGPS) arranges permit-to-work for isolation of local AVSU
- establish, in consultation with surgical or clinical practitioners, the possible nature and volume of the contaminant
- consult the infection control officer to ascertain the level of microbiological hazard, including the pathogenicity and persistence of any infectious agents
- from a study of the as-fitted drawings, identify any downstream terminal units that may be flooded during the cleaning process
- a solution of 1% Teepol/ Savlon/ sodium dichloroisocyanurate in about 10 litres of hot water should be prepared
- 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
- other downstream terminal units should be checked for presence of solution. Where found, each should be flushed in a similar manner
- repeat the procedure using clean hot water
- ensure that the pump removes as much water as possible from the system
- take the system back into use, leaving the cleaned terminal units with a low flow via suction controller regulators
- check plant filters for evidence of fluid
- where present, change the bacteria filters
- monitor the system for a few days, with vacuum control units fitted, for evidence of liquid

Work on anaesthetic gas disposal systems

D.30 Bacteria filters are not usually included in the air pathway of anaesthetic gas scavenging system (AGSS) pump units and may also be absent from the patient breathing circuit exhaust.

D.31 Given the high flow rates in such systems, condensation of moisture in the pipework between terminal units and pumps is unlikely.

D.32 Some condensation may occur in the exhausts of AGSS 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.

D.33 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’.

D.34 However, even without detectable condensation, microbiological contamination of anaesthetic gas scavenging (AGS) pipelines is not unknown, and unnecessary exposure should be avoided.

D.35 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.

D.36 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 for VIE installations

E.1 This Scottish Health Technical Memorandum (SHTM) defines the role and responsibilities of the Authorised Person medical gas pipeline systems (MGPS) (AP (MGPS)) with respect to the permit-to-work system and other MGPS duties.

E.2 However, there are specific duties associated with the management of cryogenic oxygen supplies. These are summarised below. (This is not an exhaustive list):

- liaison with the gas supplier to ensure the most cost-effective solution to the healthcare facility's oxygen supply requirements. This will involve the AP (MGPS), the healthcare facility's risk manager, the chief pharmacist (or Quality Controller (MGPS) (QC (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, not mentioned here
- assimilation of telemetry data and responding to abnormal levels of liquid consumption, vessel pressure and the like
- 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 healthcare organisation'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
- 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
- providing advice to the healthcare organisation 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 vacuum-insulated evaporator (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 healthcare facilities must define liability in the event of an incident arising from gas supply failure or contamination

- 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
- ensuring that all safety signage, lighting and antipersonnel protection required for the installation is in place and maintained. A piping and instrumentation diagram (P&ID) of the plant should be displayed clearly to indicate the appropriate valves that are necessary to operate the plant safely
- 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
- ensuring that, in addition to the routine maintenance and testing performed by the gas supplier, the basic maintenance detailed in Section 10 is carried out and recorded
- in addition to applying the permit-to-work system the gas supplier’s engineer directly employed or contracted will provide a signed copy of their service report on activities carried out to the AP (MGPS)

Appendix F Valve numbering schedule and valve status of British Oxygen Company's (BOC) and Air Products' (AP) liquid oxygen cryogenic storage vessels

F.1 Figure F.1 details the valve numbers on vacuum insulated evaporator (VIE) arrangements:

Figure F.1 - 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:	Notes:
BOC = British Oxygen Company AP = Air Products NO = Normally Open NC = Normally Closed	* 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 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.

F.2 Figure F.2 details the VIE valve status in normal and emergency operating conditions

Figure F.2 - Valve status in normal and emergency operating conditions

	Valve Status															
	V4	V4	V3	V22	V6	V21	V7	V14	V9	V12	V11	V3	V12	V2	V13	V1
Condition	BOC	AP	BOC	AP	BOC	AP	BOC	AP	BOC	AP	BOC	AP	BOC	AP	BOC	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:	Notes:
BOC = British Oxygen Company AP = Air Products V# = Valve Number NO = Normally Open NC = Normally Closed	* 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 been returned to normal, following safety-valve or bursting-disc rupture. V6/V21 must not be changed over until the pressure has returned to normal. ** V11 BOC (V3 AP) will be shut to help lower high vessel pressure but will be reopened when the pressure has returned to normal.

Appendix G Notes on use of Permit books

G.1 Permits divided into two hazard levels: high and low:

- 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

G.2 Where terminal units containing non-gas-specific components remain in use, and on occasions when the Authorised Person medical gas pipeline systems (MGPS) (AP (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.

G.3 The AP (MGPS) may well carry out such tests mechanically, for example by the use of proofing tools/ probes, intervention by the Quality Controller (MGPS) (QC (MGPS)) being unnecessary. On occasions where the AP (MGPS) considers that the risk of cross-connection warrants a deeper level of testing, the QC (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 QC (MGPS) is required.

G.4 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 AP (MGPS) and the Competent Person (MGPS) (CP(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.

G.5 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 AP (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.

G.6 The low hazard permit will not require the signature of a Designated Clinical Officer (MGPS) (DCO (MGPS)) for routine maintenance on medical gases plant when no interruption to the supply is anticipated, for example, plant oil and filter changes, but is now formalised in Scottish Health Technical Memorandum (SHTM) 02-01. However, if interruption of gas supplies to terminal units is part of the low hazard work, the AP (MGPS) must obtain the written permission of a DCO (MGPS).

G.7 Permits should be issued for all work on MGPS, including cryogenic systems, with the exception of the few situations listed in Section 6, 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

G.8 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

G.9 The following tests and checks must be carried out after complete installation of the pipeline system:

- tests for leakage on each MGPS
- tests of area valve service units (AVSU) 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 non-interchangeable screw thread (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 (MA), 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 QC (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 MA, and the system then left under pressure
- tests for anaesthetic gas scavenging disposal systems

Tests before use

G.10 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 64: That pipeline odour tests will not usually be carried out on nitrous oxide, carbon dioxide or nitrous oxide/oxygen mixture systems when carrying the working gases.

Suggested coding system for recording tests performed during validation/ verification process

High hazard permits

G.11 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 SHTM 02-01.

G.12 Should a test not covered by the coding system be applied at the discretion of the AP (MGPS), it will be necessary to insert a description of the test as concisely as possible into part 3 of the permit form.

G.13 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 Section 13, Part A, of SHTM 02-01.

G.14 If the work is the repair/ service/ maintenance of a system, the test methods may vary from those in Section 13 of SHTM 02-01 Part A. 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.

G.15 To indicate these different test methodologies, a ‘V’ should be added as a suffix to the appropriate code (see examples in the table).

G.16 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).

G.17 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

G.18 As tests are for a wide range of plant and the like 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

G.19 An increase in the number of inadvertent isolations has prompted inclusion of a fourth (green) sheet in the high hazard permit book.

G.20 On this sheet, the AP (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 Persons (MGPS) (CP (MGPS)), both AP (MGPS) and CP (MGPS) should sign the sheet, which is then retained in the permit book.

G.21 Isolation should not take place until the sheet has been completed and signed off.

Table G.1 - Description of tests and codes for use in part 3 of the permit-to-work

Description of test	Code letters for use in part 3 of permit	Notes
Carcass tests	N/A	N/A
Labelling and marking	CLM	Carcass labelling and marking (CLM)
Sleeving and supports	CSS	Carcass sleeving and supports (CSS)
Leakage (at high pressure)	CLH	Carcass leakage at high pressure (CLH)
Cross-connection	CCC	Carcass cross-connection (CCC)
Valve closure, zoning, leakage	CAC, CAZ, CAL	Carcass valve closure (CAC), carcass valve zoning (CAZ), carcass valve leakage (CAL)
System tests	N/A	N/A
Leakage (at working pressure)	SLX (SL0V)	(SLX) indicates working pressure test of section, where X=No of hours on test (SL0V) would indicate a soupy 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	System zoning of AVSUs and terminal unit identification (SZT)
Cross-connection	SCC (SCCV)	System cross-connection (SCC), (SCCV) indicates that a full cross-connection test was not performed for example, 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.

Description of test	Code letters for use in part 3 of permit	Notes
		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 and the like, 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 SHTM 02-01 will be performed every time additional terminal units are added; the methodology of this test is, therefore, at the discretion of the AP (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	System warning and alarm systems (SWA)
As-fitted drawings	SAF	System as-fitted drawings (SAF)
Purging and filling with working gases	SPF	System purging and filling (SPF), note that this test appears in part 4 of a high hazard permit, as the QC (MGPS) will normally conduct it. As such, coding is unnecessary in this part of the permit. If the system is offered to the QC (MGPS) as 'purged and filled', the code would appear in part 3

Description of test	Code letters for use in part 3 of permit	Notes
		of a high hazard permit, although this would only be allowed at the discretion of the QC (MGPS).
Particulate contamination and odour	SPO	System 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 the QC (MGPS)
Anaesthetic gas scavenging (AGS) disposal systems performance (at terminal unit)	SDT	System disposal systems at terminal unit (SDT)
AGS disposal systems performance (full test)	SDF	System disposal systems full test (SDF)

Abbreviations

AC/h: Air Changes per hour

AE (MGPS): Authorising Engineer (Medical Gas Pipeline Systems)

AGS: Anaesthetic gas scavenging

AGSS: Anaesthetic gas scavenging system

AP (MGPS): Authorised Person (Medical Gas Pipeline Systems)

AVSU: Area Valve Service Unit

BCGA: British Compressed Gas Association

BS: British Standard

BS EN ISO: British European International Standard

BSP: British Standard Pipe

C2H4O: Ethylene oxide

CCRA: Climate Change Risk Assessment

CEL: Chief Executive's Letter

CEng: Chartered Engineer

COSHH: Control of Substances Hazardous to Health

CP: Code of Practice

CP (MGPS): Competent Person (Medical Gas Pipeline Systems)

CPAP: Continuous Positive Airway Pressure

CPD: Continuing Professional Development

CSO: Contract Supervising Officer

DCO: Designated Clinical Officer

DL: Director Letter

EBME: Electronic and Biomedical Equipment

EN: European Standard

ERM: Emergency Reserve Manifold

FM: Facilities Management

GN: Guidance Note

HBN: Health Building Note

HSE: Health and Safety Executive

HSIB: Healthcare Safety Investigations Branch

ICU: Intensive Care Unit

IDP: Informed design process

IRIC: Incident Reporting and Investigation Centre

ISO: International Standard

kPa: kilo Pascal

KSB: Knowledge, skills and behaviours

LDRP: Labour, Delivery, Recovery and Post-partum

LED: Light-emitting diode

LEV: Local Exhaust Ventilation

LPG: Liquified Petroleum Gas

LVA: Line valve assembly

LLVA: Lockable line valve assembly

M^3: Cubic metre

MA: Medical air

MA4: Medical air (4bar)

MDA: Medical device alert

MGPS: Medical gas pipeline system

MGSG: Medical Gas Safety Group

MHRA: Medicines and Healthcare Products Regulatory Agency

MV: Medical vacuum

N_2: Nitrogen

N_2O: Nitrous Oxide

N_2O/O_2: Nitrous oxide/oxygen 50/50% mix

NES: NHS Education for Scotland

NIST: Non-interchangeable screw thread

NOS: National Occupational Standard

NPD: Non-profit Distributing

NPF: National Performance Framework

NRV: Non-return valve

NSS: National Services Scotland

O_2: Oxygen

^oC: Degrees Centigrade

OEL: Occupational Exposure Limit

OES: Occupational Exposure Standards

P&ID: Piping and Instrumentation Diagrams

PFI: Private Finance Initiative

PG DIP: Post-graduate Diploma

Ph. Eur.: European Pharmacopoeia

PID: Project Initiation Document

PPM: Planned Preventative Maintenance

ppm: Parts per million

PPP: Public Private Partnership

PSA: Pressure swing adsorber

PSSR: Pressure Systems Safety Regulations 2000

QC: Quality Controller

QC (MGPS): Quality Controller (Medical Gas Pipeline Systems)

QMS: Quality Management System

RIDDOR: Reporting of Injuries, Diseases and Dangerous Occurrences Regulations

RPSGB: Royal Pharmaceutical Society of Great Britain

RPS: Royal Pharmaceutical Society

RSC: Royal Society of Chemistry

SA: Surgical air

SA7: Surgical air (7 bar)

SBC: Strategic Business Case

SCQF: Scottish Credit and Qualification Framework

SFG: Service and Facilities Group

SHPN: Scottish Health Planning Note

SHTM: Scottish Health Technical Memoranda

SN: Safety Notice

SOP: Standard Operating Procedure

SQA: Scottish Qualifications Authority

SRO: Senior Responsible Officer

SSD: Sterile Services Department

STG: Synthetic Town Gas

TPI: Threads per Inch

TWA: Time-weighted averages

v/v: % volume per volume

VIE: Vacuum Insulated Evaporator

VIPR: Valve with an integral pressure regulator

VPM: Volume per million