**Health Technical Memorandum**

**02-01: Medical gas pipeline systems**

*Part A: Design, installation, validation and verification*

**Sources of supply for pipeline installations**

**Oxygen**

Oxygen is generally supplied from:

• A liquid source such as a large vacuum-insulated evaporator (VIE);

• Liquid cylinders or compressed gas cylinders; or

• A combination of these to provide the necessary stand-by/back-up capacity.

Oxygen can also be supplied from an oxygen concentrator (pressure-swing adsorber). Such systems are usually installed where liquid or cylinders are expensive, unavailable or impracticable.

**Medical air**

Medical air is usually supplied from a compressed air plant that includes high-quality drying and filtration equipment. Blending oxygen and nitrogen on-site to provide a high-quality product with minimum maintenance can also provide medical air. Where such systems are installed to provide both oxygen and medical air, nitrogen can be used for the power source for surgical tools.

**Other gases**

All other gases are supplied from cylinders.

**AVSUs**

AVSUs should be mounted at a convenient height between 1 m and 1.8 m such that they can be operated comfortably by staff without their needing to stoop or overreach (see Figure 3). The order of the location of individual valves in an array should follow that for terminal units, for example: O2, N2O and/or N2O/O2, MA, SA, VAC, He/O2.

If the array exceeds 1 m in height from top to bottom, it may be preferable to arrange them in two columns. Care must be taken to ensure that AVSUs cannot be obscured by opening doors etc.

Details of the design of AVSUs are given in Chapter 13.

**Specific labelling requirements**

All AVSUs should be labelled to identify the individual rooms, sets of terminal units etc controlled. They should be provided with flow direction arrows.

3.23 In critical care areas where dual circuits and/or subdivision of circuitry occur, terminal units require to be identified as associated with the specific AVSU. Correspondingly, AVSUs should be similarly labelled to identify the terminal units controlled.

**Cylinder manifold installations**

A cylinder manifold installation comprises a primary and secondary supply system.

Primary supply system

The primary supply is provided by two banks of equal numbers of gas cylinders which are connected to the pipeline via a control panel. The changeover from the “duty” to the “stand-by” bank of cylinders should be automatic.

Secondary supply system

An emergency reserve manifold system should be provided to form a secondary source of supply, for emergency use, or to permit servicing or repair.

**Alarm signal status unit**

The following indication of manifold conditionsshould be provided:

a. green “normal”: *normal*;

b. yellow “duty bank empty, stand-by running” :*change cylinders*;

c. yellow “duty bank empty, stand-by low”: *change cylinders immediately*;

d. yellow “emergency reserve bank low”: *reserve low*;

e. red “pipeline pressure fault”: *pressure fault*.

Conditions (b) to (e) should be transmitted to the central alarm system.

**Liquid oxygen systems**

The prime responsibility to ensure that adequate stocks of medical oxygen are available for patient use should remain firmly with the hospital’s management team. However, the hospital may agree with its gas supplier or facilities management supplier that they should manage the supplies of medical oxygen and maintain adequate stocks in the vessel. These arrangements should be clearly documented within the MGPS operational policy and procedures document.

Emergency supply provision

In the event of total plant and/or main pipeline failure, an emergency supply of oxygen should be available for patient use.

The emergency supply system should be activated automatically when the primary and secondary system is empty or fails to supply or when the hospital pipeline pressure falls below 3.8 bar. It must have the provision to automatically prevent the backflow of medical oxygen into the remainder of the pipeline system should the pipeline fail upstream of the connection.

When two separately sited VIE units are used to provide the hospital supply, the need for emergency manifold provision should be assessed against the likelihood of failure of both VIE systems and their respective feeds into the hospital pipeline.

**Medical compressed air systems**

Medical compressed air systems at 400 kPa

Air intake

The position of an air intake can have a considerable effect on delivered air quality, particularly with respect to levels of carbon monoxide. The air intake for a compressor should be located to minimise contamination from internal combustion engine exhausts and the discharge from vacuum systems, AGSS and ventilation systems or other sources of contaminants. Air intakes should be ducted where necessary to avoid contamination; a minimum height of 5 m above ground level should ensure a reasonable quality of intake air.

a. The plant should include at least two compressors, but additional compressors may be included provided that in all cases the total capacity will provide 100% of system design flow with one compressor not running;

b. the individual compressors should be arranged so that they will supply the system simultaneously if necessary;

A water content not exceeding 67 vpm (volume parts per million – equivalent to dew-point –46°C at atmospheric pressure) is specified for medical air pipeline systems. Only desiccant dryers can usually achieve this. The dryer control system should include a dew-point hygrometer and display with a minimum accuracy of ±3°C in a range from –20°C to –60°C atmospheric dew-point, with a set point of –46°C. It should be arranged that in the event of open circuit, a “plant emergency” alarm be initiated.

Surgical air systems

Surgical air at 700 kPa is only used as the power source for surgical tools. Supply systems for surgical compressed air may be a cylinder manifold system, a dedicated 700 kPa compressor system or a compressor system capable of supplying both the 700 kPa and the 400 kPa supplies.

**Medical vacuum systems**

The medical vacuum pipeline system should be designed to maintain a vacuum of at least 300 mm Hg (40 kPa) at each terminal unit during the system design flow tests.

The plant should consist of at least three identical pumps, a vacuum reservoir with by-pass facilities, duplex bacteria filters with drainage traps, appropriate non-return valves, isolating valves, gauges and pressure switches, an operating and indicating system, an exhaust system and a flow test connection. For capacities in excess of 500 L/min, two vessels that can be independently isolated should be installed.

The bacteria filter should be marked with the legend “bio-hazard”, together with a description of a safe procedure for changing and disposing of the filters and emptying the drainage trap.

**Anaesthetic gas scavenging disposal systems**

Anaesthetic gases are considered to be substances hazardous to health for the purposes of the Control of Substances Hazardous to Health Regulations 2002 (COSHH), except where they are administered to a patient in the course of medical treatment.

For operating departments, the number of disposal system pumps should be selected in accordance with the number of air-handling units that are to be installed for each operating suite. For example, if a separate air-handling unit is supplied for each suite, a separate AGS disposal system pump should be installed.

**Warning and alarm systems**

Panel location

Central indicator panel

Warning and alarm conditions for all medical gas supply systems should be displayed on a central panel located in a position where there is continuous 24-hour occupation, such as the telephone switchboard room or the porter’s lodge.

Repeater indicator panel location

Repeater panels should be provided in other locations to display all or some of the information on the central alarm so that appropriate action can be taken to ensure the continuing operation of the system. Some warning system information may be appropriate for display in specific departments.

**Identification of pipelines**

Pipelines should be identified in accordance with BS 1710:1984, and colour banding for the pipelines should be used. Colour band identification (see Figure 35) should be applied near to valves, junctions, walls etc. A label applied every 3 m and bearing 6 mm size letters should identify each gas. Self-adhesive plastic labels of

**Medical gas pipeline systems**

*Part B: Operational management*

**Basic MGPS requirements**

a. 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.

b. A **competent person** is required to prepare this written scheme. The competent person may be an organisation, and will usually be a nominated person from the insurance company that carries out periodic pressure vessel inspections. (This is not the Competent Person (MGPS) defined under the permit-to-work system in this Health Technical Memorandum.)

c. **Pressure safety valve replacement scheme (five-yearly).** This advice arises from theinherent lack of corrosion of these componentswhen used with the very dry gases in theMGPS, and is an alternative to pressure testing,which requires MGPS shut-downs and could bedangerous if line pressures were to be increasedduring patient use. Details of the procedureshould appear in the written scheme.

**The Medicines Act 1968**

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.

The pharmaceutical quality controller is responsible for quality control of medical gases.

**Emergencies**

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

a. reporting an incident;

b. action to be taken (for example turning off isolation valves, use of portable emergency cylinders);

c. liaison with other staff and departments;

d. calling out contractors.

They should be similarly familiar with the purpose of AVSUs and how to use them in an emergency.

Pharmacy staff have a responsibility for monitoring the quality of all gases delivered, including PSA, compressed air and synthetic air. It may be appropriate to include warning systems within the pharmacy department.

**Control of work**

Any work involving alterations, extensions ormaintenance work on the system should be subjectto the permit-to-work procedure set out inChapter 6, which should be under the control ofthe Authorised Person (MGPS).

**Responsibility for gas cylinders**

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

**Record drawings**

The estates department should have accurate and up-to-date drawings of the MGPS showing main sections and branches, departments served, control valves, terminal units and alarm systems for each medical gas service.

These drawings should be readily available on site for use by any Authorised Person (MGPS), and all

Authorised Persons (MGPS) should know their location.

Each isolating valve should be individually identified by a unique reference number. The appropriate reference number, corresponding to that shown on the drawings, should be displayed at or on each isolating valve. The drawing should indicate the type and make of terminal units.

**Locking of valves and plantrooms for MGPS**

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.

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.

**Application of the system**

The permit-to-work system is applicable to the servicing (including planned preventive maintenance (PPM)), repair, alteration and extension of existing MGPS within a hospital, and any action, such as the closure of an isolating valve, which restricts the supply.

A permit should be issued for all PPM work on the MGPS. This includes all examinations where no interruption to the service is anticipated.

**Training and communication**

A training programme should be established for all staff responsible for MGPS.

All training should be recorded and reviewed regularly.

**Refresher training and reassessment**

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

**Personnel Retraining Re-assessment**

Authorising Engineer Every 3 years Every 3 years

Authorised Person Every 3 years Every 3 years

Competent Person Every 3 years Every 3 years

Designated Medical Officer Every 3 years Every 3 years

Designated Nursing Officer Every 3 years Every 3 years

Quality Controller Every 5 years Every 5 years

Designated Porter Every year Every year

General Nursing staff Every year

**Segregation of gases/cylinders**

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

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

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

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

**Maintenance**

An MGPS should be subjected to a planned preventive maintenance (PPM) schedule, which should be under the responsibility of the Authorised Person (MGPS), irrespective of whether or not a full preventive maintenance scheme is being implemented in the hospital as a whole.

A permit-to-work should be issued for all examinations, even where no interruption to the service is anticipated.

The trust should have a medical gas operational policy that includes effective maintenance and sourcing of MGPS, which can be incorporated into a holistic approach. Some “added value” benefits that a trust can accrue from selecting the appropriate contractor can include the following:

• Full risk management and compliance analysis;

• Facility for full technical advice, support and back-up for service provision;

• Full asset management and expert life-cycle management;

• Condition-based monitoring and maintenance;

• Reliability-centred maintenance;

• Monitoring and setting of service quality targets;

**Planned preventive maintenance (PPM) schedules**

Records

Counters that record the hours of operation of compressors and vacuum pumps are covered in

Part A. The readings of these counters can be used in conjunction with the recommendations of the manufacturers servicing

**Daily/weekly tasks**

It is the responsibility of the Authorised Person (MGPS) to organise any necessary daily/weekly maintenance on the pipeline and plant