

SPECIFICATION FOR MEDICAL GAS SYSTEM EXTENSION OF F. NILANDHOO ATOLL HOSPITAL

Medical Gas System. According to HTM Standard.

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SPECIFICATION

1. General

1a) Specialist Manufacturer/ Supplier/Installer

Design, installation, validation and verification

The medical gas specialist shall ensure that all plant installed and all work carried out shall be as per the recommendation made in the NHS Health Technical Memorandum Number 02-01 and BS EN ISO 7396-1 and to the satisfaction of the client and MOH.

The medical gas system manufacturer shall be registered to BS EN ISO 9001:2000/BS EN ISO 13485:2003 to cover the design, manufacture and supply of medical gas equipments, the education and training to hospital engineering personnel. The medical gas system supplier and installer shall be registered to ISO 9001 for the design, supply, installation, testing and commissioning of medical gas system. The medical gas system supplier shall be approved by civil defence for central gas system installations.

C.E. MARKING

All equipments shall be "CE" marked under the Medical Devices Directive 93/42/EEC. Under this directive, the specified products are classified as Class IIa Medical Devices.

All works shall be carried out by persons fully familiar with Medical Gas Installation with minimum 3 years experience in medical gas field..

1a) Testing and Commissioning

All equipments shall be tested according to HTM Appendix A B0 to B14 and commissioned by the specialist contractor.

1b) Quality and Gas identification test certification

Quality and Gas identification test shall be carried out by NHS authorised and certified quality controller from UK to certify the system

1c) Final handing over

All system as per the contract shall be handed over according to the HTM Appendix A B0 to B16

1d) Warranty/Guarantee

All equipments shall be covered 1 year warranty from the date of final handing over

1e) Minimum qualification of installation staff

Minimum 5 years experience in the similar project and minimum 3 similar projects should be completed within last 3 year period. (Medical gas system installation, testing and commissioning).

1i) Previous project Completion certificate

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Minimum 3 project completion certificate should be provided with tender documents to covering quality and gas identification test.

1j) Responsibility

Specialist Manufacturer/Supplier/Contractor should make sure that existing and new system should work according to the latest standard. PWD/MOH authority should be satisfied.

1k) Qualifications

12 a. Company specializing in manufacturing materials, products and systems for healthcare projects of similar size and complexity with a minimum of ten years of documented experience.

12 b. One Medical Gas Equipment Manufacturer (MGEM) shall supply the medical-gas system(s) and equipment to include outlets, AVSU, alarm panels, manifolds, and vacuum sources.

12 c. The MGEM shall have a product specialist available to periodically check with the Contractor during installation of the pipeline systems equipment. MGEM shall provide service support to the hospital after turnover.

2. Equipments

a) Medical Gas Distribution System

The complete piping of the medical gas distribution shall be compliance with HTM and the piping as per the chapter chapter 13 of HTM in compliance with tender documents.

The piped distribution system shall use copper pipes manufactured from phosphorous de-oxidised nonarsenical copper to BS EN 1412:1996 grade CW024A (Cu-DHP), manufactured to metric outside diameters and having mechanical properties in accordance with BS EN 13348:2001- R250 (half hard) for sizes up to 54mm or BS EN 13348:2001 - R290 for larger sizes. Pipes shall be degreased suitable for oxygen use and cleanliness is to be maintained by filling each pipe with dry, clean, oil and oxygen free nitrogen, fitting suitable end caps and protectively wrapping. All pipework materials shall be manufactured by BS EN ISO 9001:2001 registered companies Marking For sizes up to 54mm, copper pipes shall be permanently and durably marked at regular intervals along its length with the following information:

- a) The harmonised standard number EN 13348;
- b) BSI kitemark/statement/equivalent approval;
- b) Nominal dimensions, diameter x wall thickness;
- c) Temper designation to EN 1173;
- d) Manufacturer's identification;
- e) Date of production: year and month (1 to 12)
- f) Confirmation of degreasing for oxygen;

Example: BS EN 13348 22x0.9 R250 WIELAND

LAWTON KITEMARKED DEG/MEDICAL 05 01

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Following installation, pipelines shall be clearly identified with 150mm wide adhesive labels. Labels shall be fitted near walls, risers, valves and junctions. Colour coding and labelling shall be in accordance with BS 1710:1984. Arrows to identify the direction of gas flow shall be fitted adjacent to each identification label.

Medical Gas Pipeline Fittings shall be end feed type, manufactured from the same grade of copper as the pipes and be in accordance with the requirements of BS EN 1254-1:1998 Part 1. Fittings shall be degreased suitable for oxygen use and be supplied individually sealed in protective polythene bags.

Component Cleanliness Degreasing of pipe shall be such that there is less than 20mg/m² (0.002mg/cm²) of hydrocarbons on the degreased surface when tested by the method specified in EN 723. The degreasing of fittings shall be such that there is less than 100mg/m² (0.01mg/cm²) of hydrocarbons on the degreased surface when tested by the aforementioned method. All pipeline components shall also be free of any visible liquid detergent washing or solvent degreasing. Other methods may be used if they are proven and can be guaranteed to achieve acceptable results without degradation of the component or the environment.

Brazed Pipeline Joints Copper to copper joints shall be made on site using a silver-copper-phosphorous brazing alloy type CP1 or CP4 to BS 1845 using a dry, clean, oil and oxygen free nitrogen inert gas shield with no flux. Copper to brass or gunmetal joints shall not be made on-site. Copper to brass or gunmetal joints made off-site shall utilise silver brazing material type AG13 to AG18 to BS 1845 with a flux. Such joints shall be subsequently cleaned and degreased prior to use. Where pipes are cut on site they shall be cut clean and square with the pipe axis, using wheel cutters where possible and deburred, re-rounded and cleaned off. Expanded joints shall only be used for straight pipe joints and shall not be used for pipes sizes greater than 28mm outside diameter. Expansion joints shall only be made using apparatus specifically designed for the purpose.

Pipeline Supports

Pipelines shall be supported at the intervals specified in HTM using a suitable metallic, non-ferrous material or a ferrous material suitably treated to prevent corrosion and electrolytic action. Plastic supports shall only be used for support of drops to terminal units.

Maximum intervals between pipe supports as specified in HTM:

Pipe outside diameter (mm)	HTM2022 Vertical Runs (m)	HTM2022 Horizontal Runs (m)	HTM02 Horizontal and Vertical Runs (m)
12	1.2	1.0	1.5
15	1.8	1.2	1.5
22	2.4	1.8	2.0
28	2.4	1.8	2.0
35	3.0	2.4	2.5
42	3.0	2.4	2.5
54	3.0	2.7	2.5
76	3.6	3.0	3.0

Installation

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Where pipeline pass through walls they shall be provided with copper sleeves and filled with suitable intumescent fire stopping compound. Pipeline joints shall not be located inside copper sleeves.

b) AVSU (Area Valve Service Unit)

The Area Valve Service Unit – AVSU shall conform to BS EN 739:1998, HTM and BS EN ISO 7396-1:2007. The AVSU shall provide a zone isolation facility, for use either in an emergency or for maintenance purposes. It shall also provide a physical breakpoint to allow work to be safely carried out on the pipeline. A red coloured physical barrier (spade) shall be capable of insertion when required on either side of the valve, without the need to totally dismantle the line valve. During normal service, full-flow gaskets with an 'O' ring groove on one side shall be coloured white and provide sealing between the flat face connector and ball valve. The line valve shall be brass 22mm or 28mm ball valve with PTFE seals/seats, operated by a quarter turn handle with over-travel prevention in both directions. The ball valve shall connect by 22mm or 28mm copper stub pipes to the distribution system. The assembly shall be housed in a valve box, which shall be capable of both surface and concealed installation. The box shall made from extruded aluminium with die-cast aluminium end caps to prevent corrosion, offer high strength, and resist high temperatures from brazing in close proximity. The box shall be finished in RAL 9010 polyester powder coat finish. A hinged door shall lock in the closed position and AVSU's installed adjacent to each other shall be operated by different key/lock combinations. The AVSU door shall open through a minimum of 160° to provide maximum access, and provide for natural ventilation to prevent build up of gas within the valve box. A blank zone identification label shall be provided with each AVSU 2nd fix assembly. Each AVSU assembly shall be factory tested for gas tightness.

The 2nd fix shall include a transparent plastic window incorporating the words 'Pull in Emergency and Close Valve'. In order to gain access in an emergency, a ring pull shall be fitted to the removable portion of the window. The emergency access mechanism shall be safely operable by a 5th percentile woman without the use of a tool. Glass windows shall not be used. It shall not be possible to refit or reset the means of emergency access.

A door tamper alarm facility shall be available, with a reed switch initiating a system alarm indication on the local alarm panel when the emergency access window is removed. Normally only oxygen and medical air AVSU's controlling high acuity care areas, resuscitation bays and accident and emergency wards shall be fitted with the door tamper facility.

The second fix assembly shall be manufactured from fire retardant V0 rated ABS. All wetted parts (except seals and gaskets) shall be brass or copper. Copper stubs pipes shall be manufactured from phosphorous de-oxidised non-arsenical copper to EN 1412:1996 grade CW024A, manufactured to metric outside diameters in accordance with BS EN 13348:2008 R250 (half hard). Rubber pipe grommets shall be provided to ensure any leaking gas does not escape from the box into a wall cavity. All elastomeric gas seals shall be manufactured from Viton with a Shore hardness of 75. Mild steel components shall not be used. Sacrificial protection (e.g. galvanising), passivation or painting shall not be used to provide corrosion protection. Materials shall be inherently resistant to corrosion.

The AVSU shall be fully gas specific and labelled to identify the medical gas service. The gas specific shrouds shall clearly show the gas service and use colour coding to BS EN 739:1998. Shrouds shall be pin indexed such that the only the correct shroud can be fitted to each 1st fix. Gas specific NIST connections to BS EN 739:1998 shall be incorporated on each side of the line valve and include a permanently fitted gas identification label. Pressure gas service (not vacuum) NIST connections shall incorporate 100% self sealing valves which, held closed by gas pressure until insertion of the appropriate gas specific male NIST fitting. Additional sealing of NIST fittings shall be achieved using blank NIST nuts, with a knurled outer diameter. The blank NIST nuts shall include an internal 'O' ring groove and 'O' ring to seal on the smooth outer diameter of the female NIST. Blank

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NIST nuts shall be hand tightened only. Each NIST connection shall be capable of providing a free air flow rate of 300 l/min with a pressure drop of 0.4 bar from a 4 bar nominal inlet pressure.

The AVSU shall incorporate minimum leak pressure switch connection ports on the left and right-hand sides to enable installation of a line pressure switch inside the box.

The AVSUs shall be 'CE' marked under the Medical Devices Directive 93/42/EEC with approval from notified body no. 0088 (Lloyd's Register Quality Assurance). Under this directive, the specified products shall be classified as Class IIa Medical Devices.

c) Lockable Line Valves

Medical gas line ball valves complete with lockable NIST connections and blanking spade shall be provided as a means of isolation on medical gas pipelines at positions specified in the medical gas pipeline system design. Line ball valves assemblies shall comply with NHS Health Technical Memorandum 02-01 (HTM02-01). NIST connectors shall be manufactured to BS EN 15908. Valves shall operate from the fully open to the fully closed position by manual operation of a lever through 90°. Valve nominal bores shall be equal to the nominal pipework size.

All line ball valves shall be cleaned for oxygen service. Smaller type V assemblies (15 to 54mm inclusive) shall have flat-face connectors with 'O' ring seals. The larger VF type (76 to 108mm inclusive) shall be flanged and installed with stainless steel bolts, nuts and spring washers with 3mm Viton® sealing gaskets. PTFE tape or any other thread sealing media is not acceptable.

Each Medical gas line ball valve assembly shall terminate in copper stub pipes to enable brazing direct into the distribution system using the flux less brazing technique. Valve assemblies shall incorporate a sliding lock mechanism on the handle, which can be locked in either the open or closed position using a standard padlock with a 6mm (1/4") diameter shackle. NIST blanking nuts shall be capable of being padlocked onto the NIST bodies.

Materials

Medical gas line ball valve assemblies shall be constructed in a two-piece full-bore design with brass body, Teflon® ball seals, stem packing seal, stem 'O' ring seal and a hard-chrome plated brass ball. Valves shall be designed to have a tight shut-off and blow out proof stem for protection against pressure surges. Copper stub pipes shall be manufactured from medical grade copper pipe to BS EN 13348:2001. Copper stub pipes shall be of sufficient length to enable brazing directly into the distribution system without the need for disassembly on site.

Testing

All ball valve assemblies shall be pressure tested for valve tightness and leakage prior to packing and shipping.

Performance

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Nominal Dia DIM 'A' (mm)	Torque (Nm)	Working Pressure (bar)	DIM 'B' (mm)	DIM 'C' (mm)
15mm	5.4	55	577	38
22mm	8	50	574	48
28mm	10	40	687	56
35mm	14	40	705	68
42mm	20	35	868	73
54mm	33	27	872	83
76mm	-	16	800	-
108mm	-	16	810	-

CE Marking

The line ball valves shall be 'CE' marked under the Medical Devices Directive 93/42/EEC with approval from notified body no. 0088 (Lloyd's Register Quality Assurance). Under this directive, the specified products are classified as Class IIa Medical Devices.

d) Alarm Systems

Medical Gas Central Alarm System

The Central alarm shall be a flexible, customisable medical gas central alarm system and it shall be capable of carrying up to fifteen gas services, and can consist of up to thirty-two panels, including any relay interfaces. The medical gas central alarm shall fully comply with the requirements of HTM2022, HTM, C11, BS EN 60601-1 and BS EN 60601-1-2 and BS EN ISO 7396-1. The cover, back box and bezel (if required) shall be polyester powder coated in a RAL9010 30% gloss finish. A single tamperproof fastener shall be used to gain access to the hinged door. The hinge shall operate through a minimum of 1200 to provide adequate access.

Configuration of the Central Alarm shall be done via switches on the panel, allowing easy and flexible configuration. Each panel shall display and / or input up to five gas services or up to twenty point alarms.

Each gas service shall consist of a bank of five dual-circuit LED indicators, one green (for a "Normal" indication) and three yellow and one red (for four input conditions) as standard, although panels shall be customisable for individual requirements. The gas service inputs shall be connected to a five way connector block.

The alarm shall monitor the cable connection from the source equipment, and provide a fault alarm in the event of a short circuit or open circuit fault. This shall be distinguishable from a source equipment fault.

There shall be a test facility to check the integrity of all the LED indicators on the panel, and the audible alarm. The test facility shall also provide diagnostic information to aid in fault finding. An adjustable volume audible alarm shall be fitted to the panel to allow installation in all environments, and there shall be a facility to connect the alarm to a remote sounding unit to repeat the audible alarm at other locations, for example a nurse base at the other end of a ward.

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There shall be a mute facility which silences the audible alarm for a period of fifteen minutes, or until another alarm condition occurs. There shall be a selectable option to indicate to other repeater panels around the system that an alarm condition has been acknowledged and appropriate action is being taken.

A volt free contact shall be provided to output normal/fault status for the panel.

Each panel shall be wired on to a dedicated data transmission cable and shall be permanently connected to the "Essential Supply" within the hospital via a 3A double pole switched fused spur. Each gas service will display a green "Normal" indication when all four conditions are not in a fault condition. When an input condition faults, the respective LED shall indicate the type of failure. Any data communication errors shall cause a "System Fault" alarm. A rechargeable battery shall provide a "System Fault" alarm in the event of a power failure. Source equipment shall connect directly to the input alarm panel. It is not acceptable to install a separate connection box to convert switch signals to a data signal.

The Central Alarms shall be 'CE' marked under the Medical Devices Directive 93/42/EEC with approval from notified body no. 0088 (Lloyd's Register Quality Assurance). Under this directive, the specified products are classified as Class IIb Medical Devices.

Medical Gas Area Alarm

Each medical gas area alarm panel shall be capable of monitoring 6 medical gas services by means of pressure sensors, which detect deviations from the normal operating limits of either pressure or medical vacuum. The medical gas area alarm shall fully comply with the requirements of HTM2022, HTM, C11, BS EN 60601-1 and BS EN 60601-1-2 and BS EN ISO 7396-1. The cover, backbox and bezel (if required) shall be polyester powder coated in a RAL9010 30% gloss finish. A single tamperproof fastener shall be used to gain access to the hinged door. The hinge shall operate through a minimum of 1200 to provide adequate access.

Each gas service shall be displayed by coloured LED's to show 'Normal' (green), 'Low' and 'High Pressure' (red) conditions. Medical vacuum systems shall be displayed in the 'Normal' (green) and 'Low Vacuum' (red) conditions only. Failure indicators shall be displayed by flashing lights and normal indications shall be steady. Each LED block indicator shall be a plug-in component with individual long life LED's connected in parallel in two banks to provide duplex circuits. An audible warning shall sound simultaneously with any failure indication and a mute facility shall be provided. Following a mute selection the audible will resound after approximately 15 minutes, or shall operate simultaneously should a further alarm condition occur. A "Mute" switch shall be provided inside the panel for use during any maintenance resulting in prolonged pipeline or plant shutdown. This facility shall automatically reset when the gas service returns to normal. The alarm panel shall have a 'Test' facility to prove the integrity of the internal circuits, LED's and audible warning. The alarm panel shall incorporate a volt free normally closed relay to allow for interconnection to either a medical gas central alarm system or an event recording circuit of a building management system. Each alarm shall provide a green LED to indicate that electrical power is available at the panel and a red LED to indicate 'System Alarm'. In the event of an electrical power supply failure the 'System Alarm' LED shall illuminate (flashing) and the audible warning shall be delayed for 30 seconds to enable standby generator tests. Line contact monitoring circuits shall be provided to constantly monitor the integrity of the input sensors and interconnecting wiring. In the event of any fault the line contact monitoring circuits shall initiate the specific gas service failure indication, a 'System Alarm' indication and an audible warning. Further aids to fault diagnosis shall be provided by means of varying flashing rates whilst operating the 'Test' switch.

A simple data connection shall be provided to allow connection of up to 5 repeater panels, enabling the visual and audible alarm signals to be repeated at other locations within a department. Pressure and Vacuum Switches

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Pressure and vacuum switches shall be manufactured with brass wetted parts and house a PCB with line contact monitoring resistors. Electrical connectors shall be designed for frequent disassembly. Spade connectors are not acceptable. Pressure switches shall include both high and low pressure settings in the same switch, using only a single ¼" BSPP threaded pipeline connection to minimise the number of sealed joints. The body and housing of the pressure switch shall be manufactured from impact resistance, rigid and inherently corrosion proof materials. Elastomers and plated or coated mild steel are not acceptable materials. Pressure switches shall connect directly to the area alarm panel. It is not acceptable to install a separate connection box to convert switch signals to a data signal.

The Medical Gas Area Alarms shall be 'CE' marked under the Medical Devices Directive 93/42/EEC with approval from notified body no. 0088 (Lloyd's Register Quality Assurance). Under this directive, the specified products are classified as Class IIb Medical Devices.

e) Automatic Manifold Control System for All gases and configuration as per BOQ. (Oxygen, Nitrous Oxide, Medical Air)

The Automatic Manifold shall conform to NHS Health Technical Memorandum No. 02-01 (HTM02- 01) and EN ISO7396-1. The manifold control system shall provide an uninterrupted supply of a specific medical gas from equally sized high pressure cylinder banks via a suitable arrangement of pressure regulators, providing a constant downstream nominal pipeline gauge pressure of 400 kPa, 700 kPa or 1,100 kPa. The entire system shall be 'duplexed' such that any single functional component failure will not affect the integrity of the medical gas supply. The manifold shall be supplied fully assembled and tested.

Manifold Design

There shall be two separate stages of regulation to enable high peak flow rates without a reduction in line pressure. Multistage regulators combined within a single unit are not suitable for this application, as they do not meet the required performance for this product. Regulators shall comply with BS EN ISO 10524-2 and shall have documented test reports available confirming successful completion of the oxygen ignition tests stated therein. The manifold control system shall be capable of supplying a flow of 1,750 l/min to a 400 kPa distribution system and a flow of 2,000 l/min to a 700 kPa and 11,000 kPa distribution system.

All regulators shall be protected from over pressurisation by relief valves that are vented to atmosphere. The manifold shall allow to be vented during commissioning, e.g. by using embedded test point.

A test point shall be isolated from the supply with a ball valve. The manifold shall be supplied with a non-return valve for connection to the distribution system. To minimize installation time, the test point with an antimicrobial GEM Shield medical gas outlet should be incorporated into the manifold.

The manifold assembly shall be housed in a single control panel having a solid construction using epoxy technology in a glass-reinforced polymer moulding for high chemical and corrosion resistance and high impact strength. The case shall be fully removable to provide unlimited access to all internal components. A powder coated 3mm steel backplate shall hold all components, providing additional protection and a robust fixture.

To aid maintenance, the connections within the panel shall use 'O' rings sealing against flat-face connectors to facilitate easy removal and replacement of components. To simplify installation there shall be an installation bracket attached to the wall with four screws, the main panel shall then be placed on to this bracket and be secured. A diagram shall be fixed internally to identify spare parts and wiring connections.

Control System

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The Manifold Control System shall conform to NHS Health Technical Memorandum 06-01(HTM06-01) Electrical services supply and distribution. Following Chapter 11 requirement, manufacturer shall provide an evidence of Electromagnetic compatibility (EMC) for the manifold, e.g. EMC test certificate.

The system should incorporate a graphical display to indicate pressure in each bank of cylinders and line pressure. All alarms should be duplicated on a display and embedded membrane panel with LEDs. Digital display should be backed up by mechanical gauge in case of power failure.

To increase safety, the system shall have an electronic warning signal to inform the user to perform regular maintenance. The timer should be based on a pre-defined service interval.

The system should provide an estimated average gas consumption, with a clear indication on the display for non-liquefied gases.

All electrical components shall be located in a separate enclosure to limit dust, water penetration and simplify electrical connection with BMS and Alarms.

The PCB's shall be linked with plug and socket connectors for easy removal. For added safety the voltage inside the panel shall not exceed 24V D.C.

The control system should have a coloured active matrix liquid crystal display (LCD), a driving circuit and a back light system. The display shall have a 3.5 (4:3) inch diagonally measured active display area with QVGA (320 horizontal by 240 vertical pixels) resolution.

The system should have a "screen saver" function to extend a lifetime of the display to more than 20,000 hours. To save screen life the display may run at a reduced to ½ brightness. The screen shall come to full brightness if any alarm conditions are active, and reverts back to ½ brightness 5 minutes after the panel returns to normal.

The system should have a restricted Setup Mode to allow adjusting warning levels for line pressure; select pressure measurement system between bar and psi and select the type of alarm output i.e. with Line Contact Monitoring (e.g. connection to Medipoint) or without, e.g. for 3rd party alarm system. Additionally a Service Mode shall be foreseen to deactivate alarms during commissioning and service, as well as allowing manual operation selection of a duty bank.

Power Supply

To increase serviceability, the system should have a separate power supply board. Safety approvals: UL60950-1, TUV EN60950-1 approved, compliance to EN55022 (CISPR22) Class B.

The system should have a universal input and work in a wide power range: AC 90 to 264 Volts 50/60 Hz. Power supply board should have build-in over-voltage protection circuit and overload protection which recovers automatically after the fault condition is removed.

Operation

Either the left or right hand manifold bank may be designated "Duty" and the Lifeline® Manifold shall automatically changeover to supply the distribution system from the "Standby" bank when pressure in the "Duty" bank falls to a per-determined level. Each side of the Manifold shall be capable of being fully isolated via a full flow ball valve in order to change any regulator without interruption of supply. The inlet of the 1st stage regulator shall be protected from the particulate matter by a 25µm sintered bronze filter. There shall be a fail safe system in

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the event of power failure so that solenoid valves open and there is full continuity of supply pressure and flow. Upon power restoration the unit shall revert back to the original bank of cylinders being used. Once changeover has occurred and the cylinders have been replaced, system should automatically reset alarm conditions.

There shall be manual changeover buttons so that servicing either side of the system can be simply achieved. For safety reason, manual changeover to already exhausted side should be blocked.

Materials

All polymers and elastomers in the gas flow that can be subjected to working pressure greater than 3,000 kPa shall be halogen-free. The use of PTFE, PCTFE, Viton and other halogenated polymers in these applications is strictly prohibited. Non-return valves fitted to header manifolds shall have a metallic seat with ceramic ball. Soft seat nonreturn valves utilising polymers or elastomers are not acceptable.

Modular Header Manifolds

Modular Header Manifolds shall provide connection points for flexible cupronickel tailpipes. They shall be available in 'primary' and 'secondary' configurations, with either single or double cylinder connection points. 'Primary' headers shall connect directly to the manifold control system with extensions for additional cylinders being provided by the addition of 'secondary' headers. Non-return valves shall be fitted to each tailpipe connection point to protect the system in the event of a tailpipe fracture.

Corner connectors shall be available to enable installation of manifold headers around corners of the manifold room. A custom length corner connector shall also be available to enable header manifolds to be installed in a 'U' configuration across 3 adjacent walls of a manifold room.

CE Marking

The Manifold control systems shall be 'CE' marked under the Medical Devices Directive 93/42/EEC with approval from notified body no. 0088 (Lloyd's Register Quality Assurance). Under this directive, the specified products are classified as Class IIb Medical Devices.

f) Modular Emergency Reserve according to HTM Standard for All gases and configuration as per BOQ. (Oxygen, Nitrous Oxide)

The Emergency Reserve Manifold shall conform to NHS Health Technical Memorandum No. 02-01 (HTM), BS EN ISO 7396-1, BS EN ISO 15001 and BS EN ISO 10524-2.

The manifold control system shall provide an uninterrupted supply of a specific medical gas from equally sized high pressure cylinder banks via a suitable arrangement of pressure regulators, providing a constant nominal downstream pipeline gauge pressure of 400 kPa, 700 kPa or 1,100 kPa.

The Emergency Reserve Manifold shall be supplied fully assembled and tested. A Gem Shield terminal unit test point shall be fitted, which shall be isolated from the main supply with a ball valve. The manifold shall be supplied with a non-return valve and lockable line isolation valve for connection to the distribution system, enabling a continuous supply of gas to the distribution system upon failure of the normal supply. High pressure bank isolation valves shall be supplied to enable one bank to be designated as "duty" (open in normal operation) and one bank to be designated as "standby" (closed in normal operation). Visual indication of the open bank shall be included.

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To simplify installation the manifold shall be supplied with the primary manifold headers and non-return valves for connection of tailpipes. The complete manifold shall be fitted to a wall mounting plate attached to the wall with four screws.

Pressure Regulation

There shall be two separate stages of pressure regulation to enable high peak flow rates without a significant reduction in downstream pressure. The inlet of the 1st stage regulator shall be protected from the particulate matter by a 25µm sintered brass filter. Sintered aluminium bronzes shall not be used. Regulators shall comply with BS EN ISO 10524-2 and shall be supplied with documented test reports upon request, confirming successful completion of the oxygen ignition tests stated therein.

The manifold control system shall be capable of supplying a flow of 1,200 l/min to a nominal 400 kPa distribution system, 2,000 l/min to a nominal 700 kPa distribution system and a flow of 2,000 l/min to a nominal 1,100 kPa distribution system based on a 10% reduction in flowing pressure from a static pressure set point. All regulators shall be protected from over-pressurisation by relief valves, which shall be prepiped into the manifold exhaust line stub pipe to enable the gas to be taken away and vented to atmosphere safely. Relief valves shall not be vented into the manifold room.

Materials

All polymers and elastomers in the gas flow that can be subjected to working pressure greater than 3,000 kPa shall be halogen-free. The use of PTFE, PCTFE, Viton and other halogenated polymers in these applications is strictly prohibited. Non-return valves fitted to header manifolds shall have a metallic seat with ceramic ball. Soft seat nonreturn valves utilising polymers or elastomers are not acceptable.

Emergency Reserve Manifold Operation

Either the left or right hand of the manifold bank shall be designated as “Duty”, with the other manifold bank designated as “Standby” by use of the high pressure bank isolation valves. When the bank pressure in the “Duty” bank falls to 68 bar (14 bar for nitrous oxide), a “Reserve Low” or “Reserve Fault” alarm condition shall be initiated by a contact pressure gauge, which shall be indicated on the relevant medical gas central alarm panel and/or primary supply automatic manifold panel. The “Standby” bank shall also be provided with a contact pressure gauge, such that any leakage of gas over an extended period of which causes the pressure in the standby bank to fall below 68 bar (14 bar for nitrous oxide), will also initiate a “Reserve Low” or “Reserve Fault” alarm condition.

Modular Header Manifolds

Modular Header Manifolds shall provide connection points for flexible cupronickel tailpipes. Pin indexed tailpipes shall comply to EN ISO 407:2004 as required. ‘Secondary’ headers shall connect directly to the manifold control system with extensions for additional cylinders being provided by the addition of further headers. Non-return valves shall be fitted to each tailpipe connection point to protect the system in the event of a tailpipe fracture.

Corner connectors shall be available to enable installation of manifold headers around corners of the manifold room. A custom length corner connector shall also be available to enable header manifolds to be installed in a ‘U’ configuration across 3 adjacent walls of a manifold room.

CE Marking

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The Emergency Reserve Manifolds shall be 'CE' marked under the Medical Devices Directive 93/42/EEC with approval from notified body no. 0088 (Lloyd's Register Quality Assurance). Under this directive, the specified products are classified as Class IIb Medical Devices.

g) Combined Air Plant

Combined Medical Air + Surgical Air System- 7 Bar according to HTM Standard.

Medical air shall be provided by Medical Air Plant capable of providing a net flow rate as per BOQ with two compressor not running (after dryer losses). The plant shall consist of 4 Nos. air compressors and a duplex filter/dryer module.

The combined medical and surgical air system shall conform to ISO – 7396 -1 : 2002 and NHS Health Technical Memorandum No. 02-01 (HTM). Medical quality air shall be delivered at a nominal pressure of 700 kPa (7 bar) gauge for supply of the hospitals medical and surgical air systems. The entire system shall be 'duplexed' such that any single functional component failure will not affect the integrity of the medical air supply.

Control System

The central control system shall provide an intelligent human machine interface incorporating on board flash memory and real-time clock for recording operational parameters in the in built event log. The central control system shall operate at low voltage and include BMS connection for plant fault, plant emergency, reserve fault and pressure fault. Visualisation of plant inputs, outputs and status through a web browser, using a simple Ethernet connection shall be available. The central control unit shall incorporate a user friendly 5.7" highdefinition colour display with clear pictograms and LED indicators, providing easy access to system operational information.

A mechanical back-up facility shall ensure continued operation in the event of a control system malfunction. The control system shall normally employ automatic rotation of the lead compressor to maximise life and ensure even wear.

Compressors

Compressors shall be oil injected rotary screw compressors suitable for both continuous and frequent start/stop operation at a nominal outlet pressure of 1000 kPa gauge (10 bar). Compressors shall be supplied with a block and fin style after cooler with a dedicated quiet running fan to maximise cooling and efficiency. A multi-stage oil separator, capable of limiting oil carry over to a maximum of 2 ppm shall be fitted to minimise contamination and maintenance. EFF1 (CEMEP) rated TEFC, IP55 class F electric motors shall be used and incorporate maintenance-free greased for life bearings. (Motors with lower efficiency ratings are not acceptable). Each screw compressor shall be supplied with an intelligent user interface with LCD display that provides service and warning indications, working pressure, operating temperatures, number of motor starts, on-load running hours and total running hours.

Purification Module

The duplexed filter and dryer module shall incorporate high efficiency water separators, oil filters, heatless regenerative desiccant dryer, dust/activated carbon filters and bacteria filters. Contaminants in the delivered air downstream of the bacteria filters shall be maintained at levels below those shown in the following

Contaminant	Threshold
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H2O	67ppm v/v (-46°C atmospheric dew point)
Dry particulates	0.01 mg/m ³
Oil (droplet or mist)	0.1 mg/m ³
CO(1)	5 ppm v/v
CO2	500 ppm v/v
SO2	1 ppm v/v
NO	2 ppm v/v
NO2	2 ppm v/v

Air Receiver(s)

Air receivers shall comply with DIRECTIVE 97/23/EC, supplied with relevant test certificates. Each air receiver shall be hot dip galvanised inside and out and fitted with a zero loss electronic drain valve. Float type drain valves are not acceptable. The receiver assembly shall be fitted with a pressure safety valve capable of passing the maximum flow output of the compressor at 10% receiver overpressure. The receiver shall be further protected by a safety pressure relief valve and include a pressure gauge.

Dew Point Monitoring

The dryer shall incorporate a ceramic dew point hygrometer with an accuracy of $\pm 1^{\circ}\text{C}$ in the range -20 to -80°C atmospheric dew point and 4-20mA analogue output. (Aluminium oxide or palladium wire sensors are not acceptable). An alarm condition shall trigger on the dryer control panel if the dew point exceeds a -46°C atmospheric set point. The dew point at atmospheric pressure shall be shown on the central control unit LCD display. Volt free contacts shall be included to enable the dew point alarm signal to be connected to a central medical gas alarm system and/or building management system (BMS).

CE Marking

The Medical Air plant systems shall be 'CE' marked under the Medical Devices Directive 93/42/EEC with approval from notified body no. 0088 (Lloyd's Register Quality Assurance). Under this directive, the specified products are classified as Class IIa Medical Devices.

Minimum System Specification:

Design flow	- 580 l/min.
No. of Compressors	-2 Nos.
Type of compressor	-GA5 MED.
No. of receivers	- 1 No.
Each Receiver volume	-350 ltr
Service connection	- 22mm dia
Noise level /pump	- 60 dB(A)
Motor rating (kW)	- 5.5 kW each

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Duplex Pressure reducing station 4 bar to 7 bar according to HTM Standard.

There shall be duplex pressure reducing station to reduce the pressure from 4 bar to 7 bar. It should consist of isolation valves, safety relief valves and gauges.

h) Medical Vacuum System according to HTM Standard

The Medical Vacuum System shall conform to EN ISO 7396-1 and NHS Health Technical Memorandum No. 02-01 (HTM). The Medical Vacuum System shall ensure the minimum pipeline vacuum level of 450mmHg is maintained at the plant service connection point at the rated volumetric 'free air' flow rate with two pumps in standby. The bacteria filtration system shall be 'duplexed' such that each filter can be isolated for replacement of the filter cartridge. The plant capacity shall be as per the tender BOQ and drawing.

Vacuum pumps shall be air-cooled, oil lubricated rotary vane type suitable for both continuous and frequent start/stop operation at nominal inlet vacuum levels of between 578mmHg and 728mmHg. Composite carbon fibre rotor blades shall be fitted to minimise the cost of maintenance. Rotors shall be driven by directly coupled TEFV electric motors. Pump inlets shall include a wire mesh filter and integral non-return valve to prevent oil suck back and pressure increases in the vacuum system. Each

vacuum pump shall have an integral separator filter to ensure a virtually oil-free exhaust. Each pump shall be fitted with anti-vibration pads between the pump foot and mounting frame.

The duplex bacteria filter system shall incorporate high efficiency filter elements. A differential vacuum indicator shall be installed across the filter to indicate blockage. Additional pressure sensors shall be installed at the inlet and outlet of the filter to measure the pressure drop across the filters. Each filter shall be designed and sized to carry the full plant design flow capacity with a pressure drop not exceeding 33mbar (25mmHg). Bacteria Filter elements shall have penetration levels not exceeding 0.005% when tested by the sodium flame method in accordance with BS 3928:1969 and utilising particles in the 0.02 to 2 micron size range. Drain flasks shall be connected to each filter. Drain flasks shall be manufactured from transparent Pyrex® with a polymer coating on the inner and outer surfaces in order to maintain a seal in the event of inadvertent breakage of the Pyrex® flask. All drain flasks shall be suitable for sterilisation and be connected via a manual isolating valve.

The central control system shall provide an intelligent human machine interface incorporating onboard flash memory and real-time clock for recording operational parameters in the in built event log. The central control system shall operate at low voltage and include BMS connection for common fault. Visualisation of plant inputs, outputs and status through a web browser, using a simple Ethernet connection shall be available. The central control unit shall incorporate a user friendly 5.7" highdefinition colour display with clear pictograms and LED indicators, providing easy access to system operational information. Cascading of vacuum pumps shall be achieved by measuring the vacuum level at the plant inlet with a pressure transducer. A mechanical back-up facility shall ensure continued operation in the event of a control system malfunction. The control system shall normally employ automatic rotation of the lead pump to maximise pump life and ensure even wear.

Vacuum vessel(s) shall be supplied with relevant test certificates and have a total volume of at least 100% of the plant output in 1 minute in terms of free air aspired at normal working pressure. Each vacuum vessel shall be hot dip galvanised inside and out.

Minimum System Specification:

Net flow - 270 l/min.

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No. of pumps	-2 Nos.
No. of receivers	- 1 Nos
Total Receiver volume	- 270 ltr
Service connection	- 22mm dia
Noise level /pump	- 66 dB(A)
Motor rating (kW)	- 1.1 each
Motor rated supply /pump (A)	- 10
FLC /pump (A)	- 2.8
Starting current (A)	- 14
Cooling airflow /pump(m3/sec.	- 0.1

i) Anaesthetic Gas Scavenging System according to HTM Standard.

Anaesthetic Gas Scavenging System shall be a Duplex system. The Anaesthetic Gas Scavenging (AGS) System shall comply with EN ISO 7396-2 and HTM. The AGS system shall be a dedicated, specifically designed active extraction and disposal system for waste anaesthetic gas. It shall provide a maximum flow rate of 80 l/min with a 1 kPa resistance to flow, and a minimum of 50 l/min with a 2 kPa resistance to flow at each terminal unit, irrespective of the number of terminal units in use. The AGS system shall use dedicated radial blowers in a duplex configuration. The AGS pump assemblies shall be skid mounted and included on the skid shall be the duplex pump(s), motor control unit(s) with starter/isolator, moisture drain flask and flexible connector(s) to connect the plant to the pipeline. Each pump shall include an electric motor and directly coupled impeller assembly. Impeller bearings in the pump(s) shall not require lubrication. The pump(s) shall be air cooled and rated for continuous operation.

A vacuum/flow regulating valve shall be provided, comprised of a spring-loaded plate valve and inlet silencer. The plate shall control air ingress into the pipeline system, thereby controlling the vacuum level within. The number and installed position of the regulating valves fitted to the system shall be determined by the pipeline designer. The vacuum/flow regulating valve shall ensure a maximum vacuum of 150mb below atmospheric pressure is not exceeded.

Each motor control panel shall incorporate an emergency panel isolation switch facility, which controls all electrical power to the exhaustor unit, remote start switch panels and system indication lights. All control and status indication circuitry shall be limited to 24V a.c. A green 'POWER ON' indicator shall be fitted to the starter/isolator panel, and shall illuminate whenever power is available to the 24V control and indication circuit. A 'HAND/OFF/AUTO' switch shall be provided to control operation of the pump, running the pump continuously when selected to 'HAND'. When selected to 'AUTO', control of the pump shall be passed to the remote start switch panels. Operation of any of the remote start switches shall activate the pump. The pump shall continue to run until all remote switches are selected 'OFF'. The starter/isolator panel shall incorporate a thermal protection overload device. The thermal protection overload device shall also monitor the electrical power supply and phase input. In the event of a fault, the overload device shall break the circuit to the pump, preventing operation until the system is manually re-set. Operation of the overload device shall also break the circuit to the remote start switch panels, extinguishing the green running indicator.

Duplex units incorporate line pressure switch. This line pressure switch monitors vacuum levels and provides an additional control of the remote start switch and starter/isolator panel green 'RUNNING' indicators.

Duplex installations shall use remote start switches that include an amber 'PLANT FAULT' indicator. This shall illuminate, if either pump is set to 'HAND', or if one of the overloads trip. A red 'PLANT EMERGENCY'

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indicator shall also be provided and shall illuminate on all remote start switch panels if the vacuum level falls below the pressure switch set point level when the pump has been called. Where a duplex system is installed each pump shall be controlled by a separate motor control panel to enable servicing of either pump or control gear whilst maintaining system operation.

Terminal unit shall be provided with an adjustable orifice to allow balancing of the terminal unit flows during commissioning. (Venturi style terminal units are not acceptable. Terminal units shall not be connected to the medical vacuum system).

if a separate air-handling unit is supplied for each suite, a separate AGS disposal system shall be installed.

Minimum System Specification:

- 1) Duplex AGS Plant- 260lpm- qty. 1 Nos.
0.37kw x 2 Nos. Pump

j) Wall mounted outlets

The medical gas terminal units shall conform to BS EN ISO 9170-1 and accept probes to BS5682. Terminal units shall be capable of singlehanded insertion and removal of the medical gas probe. The anaesthetic gas scavenging (AGS) terminal unit shall conform to BS6834.

The first fix assembly shall consist of brass pipeline termination block with copper stub pipe secured between a back plate and a gas specific plate to allow limited radial movement of the copper stub to align with the pipeline.

For wall mounting a backbox suitable for flush or surface mounting shall be provided with the first fix along with a plastic plaster shield suitable to cover the 1st and second fix terminal unit, in order to prevent dirt ingress during construction or finishing of the wall surface.

The gas specific plate shall be fixed to the backplate by means of a tamper proof clip-fit mechanism. The first fix shall incorporate a maintenance valve (except for vacuum) and a test plug. The test plug shall provide an effective blank to enable carcass pressure testing.

The second fix plastic components shall be manufactured with the pin index permanently moulded into the gas specific socket. The socket assembly shall retain a capsule assembly, containing the check valve and probe 'O' ring seals. Second fix terminal units shall be supplied with the anti-rotation pin loose and bagged to be fitted as required.

The replaceable capsule assembly shall enable all working parts subject to wear through usage to be replaced as a factory tested assembly, thereby reducing maintenance time. Each termination block assembly shall be pressure tested by the pressure decay method.

Gas Specificity

Terminal units shall be gas specific and only accept the correct medical gas probe. Gas specific components shall be pin-indexed to ensure that a correct gas specific assembly is achieved so that in normal course of dismantling for repair or maintenance, parts from other gases cannot inadvertently be used. Wall mounted and bedhead terminal units shall incorporate an anti-rotation pin to engage with connected downstream medical equipment ensuring correct orientation.

Materials

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All screws, probe roller pins, locking springs and the anti-rotation pin shall be manufactured from stainless steel. The second fix assembly shall incorporate three injection moulded parts in fire-retardant nylon 66. All wetted parts (except seals) shall be brass or copper. Copper stubs pipes shall be manufactured from phosphorous de-oxidised nonarsenical copper to BS EN 1412 grade CW024A, manufactured to metric outside diameters in accordance with BS EN 13348 R250 (half hard). All elastomeric seals shall be manufactured from Viton with a Shore hardness of 75.

Antimicrobial Additive

All user accessible parts, 2nd fix, gas ID ring, plaster box, trim plate and inks shall include a silver antimicrobial additive for inherent antimicrobial protection.

Pipeline Connections

Terminal units installed in walls, bedhead trunking, headwalls or fixed pendants shall be connected to the pipeline with a copper stub pipe. Pressure gases and vacuum shall incorporate a 12mm O/D copper stub pipe. Terminal units for anaesthetic gas scavenging shall incorporate a 15mm O/D copper stub pipe.

Performance

Pressure drops across the terminal unit shall comply with clause 4.4.11 of BS EN ISO 9170-1. The flow/pressure drop characteristics for the Gem terminal unit are shown below with the maximum allowable value.

Nominal pressure (kPa)	Test pressure (kPa)	Flow (l/min)	EN 9170-1 limit (kPa)	Gem 10 (kPa)
400-500	320	40	15	0.6
400-500	320	200	70	14
700-10000	560	350	70	30
Vacuum	*40	25	15	1.1

CE Marking

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