



REPUBLIC OF KENYA
MINISTRY OF HEALTH

EAST AFRICA'S CENTERS OF EXCELLENCE FOR SKILLS AND
TERTIARY EDUCATION IN BIOMEDICAL SCIENCES

PROPOSED CONSTRUCTION OF EAST AFRICA'S KIDNEY INSTITUTE
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MEDICAL GAS SERVICES INSTALLATIONS
(ALL RATES EXCLUSIVE OF TAXES)

EMPLOYER

PRINCIPAL SECRETARY
MINISTRY OF HEALTH
P.O BOX 30016-00100
NAIROBI, KENYA

EMPLOYER'S REPRESENTATIVE

WORKS SECRETARY
STATE DEPARTMENT OF PUBLIC WORKS
P.O BOX 30743-00100
NAIROBI, KENYA

PROJECT MANAGER

PROJECT MANAGER
EAST AFRICA'S CENTRE OF EXCELLENCE
PROJECT
MINISTRY OF HEALTH
P. O. BOX 30016 – 00100
NAIROBI, KENYA

LEAD CONSULTANT

M/S POLITECNICA INGEGNERIA ED
ARCHITETTURA SOCIETA COOPERATIVA
220, VIA GALILEO GALILEI 41126
MODENA; ITALY

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1. PART A: GENERAL MECHANICAL SPECIFICATION

1.1. GENERAL

This section specifies the general requirements for plant, equipment and materials forming part of the Sub-Contract Works and shall apply except where specifically stated elsewhere in the Specification or on the Sub-Contract Drawings.

1.2. QUALITY OF MATERIALS

All plant, equipment and materials supplied as part of the Sub-Contract Works shall be new and of first-class commercial quality, shall be free from defects and imperfections and where indicated shall be of grades and classifications designated herein.

All products or materials not manufactured by the Sub-Contractor shall be the products of reputable manufacturers and so far, as if they had been manufactured by the Sub-Contractor.

Materials and apparatus required for the complete installation as called for by the Specification and Sub-Contract Drawings shall be supplied by the Sub-Contractor unless mention is made otherwise.

Materials and apparatus supplied by others for installation and connection by the Sub-Contractor shall be carefully examined on receipt and stored. Should any defects be noted, the Sub-Contractor shall immediately notify the Engineer.

Defective equipment or that damaged in the course of installation or tests shall be replaced or repaired to the approval of the Engineer.

Medical gas plant supplier/constructor shall be a qualified company with relevant references for this specific type of work.

1.3. REGULATIONS AND STANDARDS

The Sub-Contract Works shall comply with the current editions of the following: -

- (a) The Kenya Government Regulations.
- (b) The United Kingdom Institution of Electrical Engineering Regulations for the electrical equipment of buildings.
- (c) The United Kingdom Chartered Institution of Building Services' Guides.
- (d) The Kenya Bureau of Standards Specifications.
- (e) British Standards and Codes of Practice as published by the British Standards Institution.
- (f) The Local Council By-laws.
- (g) The electricity Supply Authority By-laws.
- (h) The Kenya Building Regulations.
- (i) The BS EN ISO 7396-1:2016 Medical gas pipeline systems. Pipeline systems for compressed medical gases and vacuum

1.4. ELECTRICAL REQUIREMENTS

Plant and equipment supplied under this Sub-Contract shall be complete with all necessary motor starters, control boards, and other control apparatus. Where control panels incorporating several starters are supplied they shall be complete with a main isolator.

The supply power up to and including local isolators will be provided and installed by the Electrical Sub-Contractor. All other wiring shall be as described in the Particular Specification.

The Sub-Contractor shall supply three copies of all schematic, cabling and wiring diagrams for the Engineer's approval.

The starting current of all electric motors and equipment shall not exceed the maximum permissible starting currents described in the Kenya Power and Lighting Company Ltd.'s By-laws.

All electrical plant and equipment supplied by the Sub-Contractor shall be rated for the supply voltage and frequency obtained in Kenya, that is 415 volts, 50HZ, 3-phase or 240 volts, 50HZ, 1-phase as specified in the particular specification.

Any equipment that is not rated for the above voltage and frequencies may be rejected by the Engineer.

1.5. TRANSPORT AND STORAGE

All plant and equipment shall, during transportation be suitably packed, crated and protected to minimise the possibility of damage, and to prevent corrosion or other deterioration.

On arrival at site all plant and equipment shall be examined and any damage to parts and protective priming coats made good before storage or installation.

Adequate measures shall be taken by the Sub-Contractor to ensure that plant and equipment do not suffer any deterioration during storage.

Prior to installation all piping, plant and equipment shall be thoroughly cleaned.

If, in the opinion of the Engineer any equipment has deteriorated or been damaged to such an extent that it is not suitable for installation, the Sub-Contractor shall replace this equipment at his own cost.

1.6. SITE SUPERVISION

The Sub-Contractor shall ensure that there is an English-speaking supervisor on the site at all times during normal working hours.

1.7. INSTALLATION

Installation of all special plant and equipment shall be carried out by the Sub-Contractor under adequate supervision from skilled staff provided by the plant and equipment manufacturer or his appointed agent, in accordance with the best standards of modern practice to the relevant regulations and standards described under clause 2.3 of this section.

1.8. TESTING

1.8.1. General

All testing shall be carried out to the entire satisfaction of the Engineer.

The following sub-clause are intended to define the Sub-Contractor's responsibilities with respect to testing and inspection.

1.8.2. Materials Tests

All materials for plant and equipment to be installed under this Sub-Contract shall be tested, unless otherwise directed, in accordance with the relevant B.S. Specification concerned.

For materials where no B.S Specification exists tests are to be made in accordance with the best modern commercial methods to the approval of the Engineer having regard to the particular type and application of materials concerned.

The Sub-Contractor shall prepare specimens and performance tests and analyses to demonstrate conformance of the various materials with the applicable standards.

If stock material, which has not been specifically manufactured for the plant and equipment specified is used, then the Sub-Contractor shall submit satisfactory evidence to the Engineer that such materials conform to the requirements stated herein in which case test of material may be partially or completely waived. Certified mill test reports of plates, piping and other materials shall be deemed acceptable.

1.8.3. Manufactured Plant and Equipment - Works Tests

The rights of the Engineer relating to the inspection, examination and testing of plant and equipment during manufacture shall be applicable to the Insurance Companies or Inspection Authorities so nominated by the Engineer.

The Sub-Contractor shall give two weeks' notice to the Engineer of the manufacturer's intention to carry out work tests and inspection.

The Engineer or his representative shall be entitled to witness such tests and inspections. The costs of such tests and inspections shall be borne by the Sub-Contractor.

Six copies of all test and inspection certificates and performance graphs shall be submitted to the Engineer for his approval as soon as possible after the completion of such tests and inspections.

Plant and equipment which is shipped before the relevant test certificate has been approved by the Engineer shall be shipped at the Sub-Contractor's own risk and should the test and inspection certificate not be approved; new tests may be ordered by the Engineer at the Sub-Contractor's expense.

1.8.4. Pressure testing

All pipework installation shall be pressure tested in accordance with the requirements of the various sections of this Specification. The installation may be tested in sections to suit the progress of the works, but all tests must be carried out before the work is buried or concealed behind building finishes. All tests must be witnessed by the Engineer or his representative, and the Sub-Contractor shall give 48 hours' notice to the Engineer of his intention to carry out such tests.

Any pipework that is buried or concealed before witnessed pressure tests have been carried out shall be exposed at the expense of the Sub-Contractor and the specified tests shall then be applied.

The Sub-Contractor shall prepare test certificates for signature by the Engineer and shall keep a progressive and up-to-date record of the sections of the work that have been tested.

1.9. COLOUR CODING

Unless stated otherwise in the Particular Specification all pipework shall be colour coded in accordance with the latest edition of B.S.1710.

1.10. Welding

1.10.1. Preparation

Joints to be made by welding shall be accurately cut to size with edges sheared, flame cut or machined to suit and the required type of joint. The prepared surfaces shall be free from all visible defects such as laminations, surface imperfections due to shearing or flame cutting operation, etc., and shall be free from rust scale, grease and other foreign matter.

1.10.2. Method

All welding shall be carried out by the electric arc process using covered electrodes in accordance with B.S. 639.

Gas welding may be employed in certain circumstances providing that prior approval is obtained from the Engineer.

1.10.3. Welding Codes and Construction

All welded joints shall be carried out in accordance with the following specification: -

1.10.4. Pipe Welding

All pipe welds shall be carried out in accordance with the requirements of B.S. 806.

1.10.5. General Welding

All welding of mild steel components other than pipework shall comply with the general requirements of B.S.5135:1974.

1.10.6. Welder's Qualifications

Any welder employed on this Sub-Contract shall have passed the trade test as laid down by the Government of Kenya.

Trade engineer may require to see the appropriate certificate obtained by any welder and should it be proved that the welder does not have the necessary qualifications the Engineer may instruct the Sub-Contractor to replace him by a qualified welder.

1.11. GENERAL MECHANICAL SPECIFICATION

1.12. INTRODUCTION

This standard specification is intended to form part of the general specification to be included in the Standard Tender document as follows:

- Part (1) General Conditions of contract.
- (2) Preliminary clauses (supplementary to General Conditions)
- (3) Technical specification(s)
- (4) Schedules of works.
- (5) Appendices to specifications.

The specification comprises standard clauses, which can be used to complete specifications for Medical Gases, Air and Vacuum installations in Hospitals. The clauses are so arranged that they can be selected to suit the requirements of individual schemes and guidance notes are included to assist in the selection and completion of the clauses. All the clauses may not apply. It may also be necessary to add clauses to suit particular requirements. These should be considered for future inclusion in the specification.

Dimensions and values are given in Metric S.I. units; Imperial equivalents are quoted in brackets. Where precision in equivalent values is not important, the nearest practical or rational equivalent in Metric or Imperial units is given.

Note; - This specification does not cover the requirements for Pathology Departments, Laboratories or Workshop. These departments must be treated separately and supplied from installations independent of Medical installations. Specifications will need to be drawn up based on appropriate sections of H.T.M. 02-01.

It is intended that design guidance for Medical installations is obtained from HTM-02-01 and that the requirements arrived at are written into the specification clauses.

REFERENCES

1.13. BRITISH STANDARDS INSTITUTION

BS 4	Structural steel sections.
BS21	Pipe Threads.
BS3643	I.S.O Metric screw Threads.
BS341	Valve Fittings for compressed Gas Cylinders.
BS1319	Medical Gas Cylinders and Anaesthetic Apparatus.
BS587	Motor Starters and controllers.
BS2613	The Electrical performance of Rotating Electrical Machinery.
BS2960	Dimensions of 3 phase Electric Motors.
BS3979	Dimensions of Electric Motors, Metric Series.

BS89	Direct Acting Electrical indicating instruments.
BS559	Light Gauge copper tube, imperial sizes-inch bores.
BS2871	Part 1. Copper tubes for water, gas and sanitation – Metric outside Diam's.
BS1172	Phosphorous Deoxidised Non-arsenical copper for General Purposes.
BS1845	Filler Metals for Brazing.
BS1723	Specification for Brazing.
BS487	Part 1: Fusion welded steel air receivers (for pressures not exceeding 500lb/sq.inch).
BS1123	Safety Valves, Gauges and fittings for air receivers and compressed air installations.
BS1780	Bourdon Tube pressure and vacuum gauges.
BS1701	Air Filters for air supply for compressors, etc.
BS 2831	Methods of air filters in filters used in air conditioning and general ventilation.
BS3928	Methods for sodium flame test for air filters.
BS4001	Care and maintenance of underwater breathing apparatus. Part 1 compressed air open circuit type. Part 2 standard diving equipment.
BS4275	Selection, use and maintenance of respiratory equipment.
BS 3970	Steam sterilizers.
BS4199	Surgical suction apparatus. Part 1 and 2 electrically operated surgical suction apparatus.
BS3636	Methods for proving Gas Tightness of vacuum or pressurised plants.
BS1710	Identification of pipelines.
BS4099	Colours and their meanings when used for indicator lights.
CP3009	Underground piping systems.
BS4957	Hospital Medical vacuum pipe line service.
HTM	Hospital Technical Memorandum

1.14. DHSS PUBLICATIONS

Hospital Technical Memorandum No. 02-01 Piped medical gases, medical compressed air and medical vacuum installations. Data sheet EE10.11/12 colour code identification for medical gas terminal units and pipe installations.

2. PART B: STANDARD SPECIFICATIONS

2.1. GENERAL

2.1.1. Extent of Contract.

The work shall include for supplying, installing, testing, commissioning, demonstrating and leaving in proper working order a piped centralised supply system for medical gases comprising (specify either : oxygen, Nitrogen Oxide/Oxygen mixture, carbon dioxide, compressed air and vacuum) as outlined in this specification. Tenders shall comply in all respects with the specification, but the contractor may offer alternatives provided that the differences and advantages are clearly detailed by him on the schedule of alternatives attached which shall be returned with the tender.

2.1.2. Specialist Contractors.

The work shall be tendered for by approved contractors only who are specialists in the installation of medical gas systems and who have permanently employed staff experienced in this type of work. At the time of tendering the contractor shall confirm in writing that he has suitable qualified personnel who would be employed on the project.

2.1.3. Contract Drawings.

The contract drawing to be read in conjunctions with this specification are as follows
Any discrepancies between the drawings and the specification shall be clarified with the Engineer before tendering.

2.1.4. As- Installed Drawings

During the course of construction, the contractor shall correct one copy of the contract drawings daily as the work proceeds, indicating any change made from the arrangement shown in the contract drawings.

This amended drawing shall remain on site, readily available for inspection, and the amendments must ultimately be transferred to a reproducible copy of the contract drawing.

2.2. CENTRALISED STORAGE CYLINDER SYSTEMS

2.2.1. Gases to be dispensed from cylinders

The supply system (s) for ((specify either: oxygen, Nitrogen Oxide/Oxygen mixture, carbon dioxide, compressed air and vacuum)) shall (each) comprise a centralised battery of cylinders, complete with support tacks, headers, automatic manifold distribution panel (s) and shall necessary controls, safety devices, alarms, pipework, valves and terminal units for distributing the gases to the required positions as listed on the schedule of terminal units.

Note: The following shall be supplied from plant installations as specified later.

- (a) Oxygen
- (b) Compressed Air.
- (c) Vacuum.

2.2.2. Location of cylinders.

The cylinders shall be located on the medical gases manifold room(s) as indicated on contract drawing(s) No (s). 2 to 6 (2, 3, 4, 5, 6).

2.2.3. Initial complement of cylinders.

The Hospital authority shall be responsible for providing the full complement of cylinders for each gas as required and these will be used initially for purging and commissioning and handing over the system(s) in proper working order. (see 10.14 and 10.15)

2.2.4. Capacity of System(s)

The capacity of the storage cylinder system(s) shall be as follows; providing equal banks of cylinders, one for 'duty' and one for 'standby' for oxygen, a total of 10 (+5) cylinders arranged in two separate banks each cylinder having a capacity of 47 litres (1330.8 cu.ft) for nitrous oxide, a total of 6 (+3 cylinders arranged in two separate banks each cylinder having a capacity of 47 litres(1330.89 cu.ft) for nitrous oxide oxygen mixture a total of 16 cylinders arranged into separate banks.

2.2.5. Cylinder support racks.

The supporting steelwork for the cylinders shall hold them in an inclined position against the wall and shall consist of mild steel bulb angle section 178mm x 176mm 'rag' bolted to the floor and a separate mild steel angle section 102mm x 76mm x 13mm thick 'rag' bolted to the wall. The steel sections to be to BS.4. The angle section shall have neatly formed semi-circular cut-outs to space and support the cylinders in banks. All securing bolts shall be provided by the specialist contractor who shall mark out the position of holes in floor and walls for drilling by the building contractor. Any grouting in shall be done by the specialist contractor, who shall also erect the steelwork.

2.2.6. Additional Racks for Spare Cylinders.

The following additional storage racks shall be provided and installed in the position(s) shown on the contract drawing(s). The racks to be in accordance with BS. 1319.

1 Rack each for 5 oxygen cylinders 47 litres (1330.8 cu.ft) capacity.

1 Rack each for 3 Nitrous oxide/oxygen mixture cylinders of 47 litres(1330.9 cu.ft) capacity.

1 Rack(s) each for 5 Compressed air cylinders of 47 litres (1330.89 cu.ft) capacity.

Note; - In cold weather N₂O/O₂ mixture tends to separate and the cylinders received should be stored horizontally for 24 hours before use. The racks shall be designed for horizontal storage only. The ambient room temperature shall be within the range of 10°C to 25°C.

2.2.7. Automatic manifold assembly.

The manifolds for all the specified gases (and air) shall be as far as possible identical in construction and the following clauses refer to the assemblies any of the “gases”.

2.2.7.1. Manifold Headers

Each bank of cylinders shall be located beneath a high-pressure manifold header securely mounted control panel. The headers shall carry flexible spiral tail pipes on the underside for connecting to the cylinders and each tail pipe shall incorporate a renewable non-return valve on the manifold header to allow removal and replacement of the cylinder without interrupting the supply from others in the same bank.

2.2.7.2. Non-interchange ability of cylinder connections

The screwed connections of the tail pipes to the cylinder valves shall be designed such that cross connection of the pipe for any one gas cannot be made to any cylinders for the gases, the exception being oxygen and air which to BS. 341 part 1 are identical.

2.2.7.3. Testing of Headers.

The manifold and tail pipe assembly shall be capable of withstanding a maximum working gauge pressure of 136 bar (1980 p.s.i.) and shall be tested to twice this pressure by the manufacturer at his work and a test certificate supplied.

2.2.7.4. De-Greasing

The assembly shall be de-greased and delivered to site in a sealed polythene bag or cover and labelled to the effect that it is de-greased and shall on no account be contaminated by dirt oil or grease during erection of afterwards.

2.2.7.5. Manifold Control Panel

Each pair of headers shall connect to a control panel which shall automatically reduce the high pressure gas or air to a low distribution gauge pressure of 4.14 bar+ 0.14 bar (60 p.s.i.+ 2 p.s.i) for gases or 7.3bar + 0.15 bar (105p.s.i. + 2.5p.s.i) for air.

2.2.7.6. Automatic Operation

The control panel shall dispense gas (or air) from each of the two cylinder banks in turn via a common distribution pipe and when the “duty” bank pressure falls to 7 bar g.(100 p.s.i.) on “gas” manifolds or 10 bar g. (145 p.s.i.) on air manifolds, the panel shall automatically switch over to the “reserve” bank without any interruption of the supply.

The panel shall incorporate a pressure regulator, a pressure switch and automatic valve to each bank in order to carry out the above operations.

It shall be possible to select either bank of cylinders as the duty bank and to change over manually to the reserve bank despite any electrical supply failure.

A reserve pressure regulator to each bank shall automatically take over if the changeover valve fails to operate or if the low-pressure regulator fails to open

sufficiently. It shall be possible to carry out maintenance work on the pressure regulators and parts for one bank without affecting the supply from the other bank.

Automatic panel shall be capable of passing 300 litres per minute at a gauge pressure of 4.14 bar (60 p.s.i.) for “gases” and 7.3 bar (105 p.s.i) for air.

2.2.7.7. Pressure Gauges

The control panel shall incorporate three pressure gauges: one high pressure gauge to each cylinder bank and one common low-pressure gauge on the outgoing supply to the distribution pipework.

The gauges shall conform to BS.1780 and be graduated in bars and p.s.i.

Each gauge shall carry the name of the gas on the dial face with warning- “USE NO OIL OR GREASE” Gauge shall be degreased and maintained in this condition before and after installation.

The dials shall be marked with a blue line at the normal working pressure and a red line at the minimum allowable.

2.2.7.8. Control Panel Identification

Each panel shall carry in large letters on the front the name of the gas being controlled the letters shall be embossed engraved or otherwise marked on so as to be indelible. Painting or adhesive lettering shall not be permitted.

2.2.7.9. Heated Manifold for Nitrous Oxide and Nitrous Oxide/Oxygen Mixture.

On the Nitrous oxide and Nitrous Oxide/oxygen mixture manifolds, electric heating elements shall be incorporated.

2.2.7.10. Electricity supply

The manifolds shall be suitable for operating from 240 volts, single phase/3 phase and neutral 50 A.C. supply.

Any internal wiring in the panel shall have a flame- retardant sheathe to comply with I.E.E regulation B. 16.

2.2.7.11. Precautions against Leakages.

All parts of the control panel shall be constructed of materials, which will not deteriorate during service and lead to leakages. Diaphragm gaskets of pressure regulators shall not be of fibre but brass.

2.2.8. Service or Emergency Point.

Each gas (or air) installation shall include a service or emergency point in the manifold room on the wall near to the control panel and on the outgoing distribution pipe into which a supply can be connected manually from a standby cylinder when the control panel is to be serviced or has failed.

The service point shall be in form of a terminal unit complete with check valve and isolating valve, into which a flexible pipe with probe can be inserted. See 6.11.8 for details.

The unit shall be capable of passing 275 litres/min. minimum at a nominal gauge pressure of 4.1 bar (60 p.s.i.) with a pressure loss not exceeding 0.55 bar (8 p.s.i.).

The unit shall be rigidly piped up to the distribution main and the height of the unit above floor level shall be such that the flexible pipe probe can be inserted easily by a person of average height standing on floor level.

The service point shall be identified indelibly with the name of the gas and by colour code to B.S. 1710 (1971), schedule No. 13 of this specification.

2.2.9. Standby Cylinder and Rack.

The standby cylinder shall be complete with pressure reducing set with safety relief, high and low-pressure gauges, on/off control valve, flexible pipe and probe.

The supply of the cylinder shall be the responsibility of the hospital authority but a supporting steel work rack on the lines of those for the main banks and reducing sets, gauges and valves shall be included in this contract.

Regulators should have a working capacity of 300 litres min. and be set to operate at a gauge pressure of 4.1 bar (60 p.s.i) for oxygen, for nitrous oxide 4.1 bar (60 p.s.i.) and for compressed air 7.2 bar (105 p.s.i.) .

The probe and the connection of the pipe to the pressure regulator shall be non-interchangeable with other gases.

2.2.9.1. Main Stop Valve.

A main stop valve shall be fitted on the distribution main before the service point is reached in order to allow the control panel to be isolated.

The valve shall be in readily accessible position so that it can also serve as an emergency valve and being located in the manifold room. It need not be housed in a valve box.

2.2.9.2. Safety Relief Valve.

A self – closing safety relief valve shall be fitted on the distribution pipe-in between the control panel and the main stop valve. The valve shall flow capacity a head equal to the maximum flow rate of the control panel and shall be set to operate at 25% above the distribution pressure.

The valve shall be of a type which can be locked or sealed and shall be non-ferrous material.

It shall be coupled to a copper vent pipe one size larger than the distribution pipe and vented to atmosphere at a suitable level and position outside the building. The end of the vent pipe shall terminate in an inverted "U" bend with wire mesh and a suitable shield to protect against snow and ice. The discharge point shall be finally agreed on site by the engineer and contractor to ensure that there is no danger of fire, injury to personnel, contamination or interference with air intakes or windows. The safety valve and vent pipe shall be supplied and installed in a degreased condition. Weatherproof notices shall be fixed at each discharge point stating- DANGER KEEP CLEAR. MEDICAL GAS DISCHARGE POINT.

2.2.10. Electrical Installation work.

All electrical equipment shall be supplied and installed by the specialist contractor. The interconnecting wiring shall be carried out to separate specification by the contractor/others.

The specialist contractor shall in all cases supply duplicate wiring diagrams and instruction within 4 weeks of being awarded the contract.

2.3. LIQUID OXYGEN PLANT

2.3.1. Extent of Specialist Contractors Work

The oxygen supply to the distribution system shall be from a medical liquid oxygen plant which shall be installed by a specialist oxygen supplier under a separate contract negotiated by the engineer.

The specialist contractor's work shall commence at the valve distribution position installed by the specialist oxygen supplier at the position shown on the Contract Drawing No 1.

2.3.2. Work Specialist Oxygen Supplier

The work shall comprise the supply and installation of a medical liquid oxygen plant at the position shown on Contract Drawing No 1.

The plant shall be the vacuum insulated evaporator type and have a capacity equal to 6 m³ (211.88 cu.ft.) of gaseous oxygen.

The plant will remain the property of the selected supplier who shall remain and re-fill with the liquid oxygen as necessary.

The plant shall include a standby oxygen cylinder twin manifold which shall come into operation immediately the liquid plant ceases to operate from any cause whatsoever.

The manifold assembly shall also remain the property and responsibility of the specialist supplier as regards regular inspection and maintenance, but daily running of manifold and replacement of cylinder as required shall be responsibility of the Hospital Authority.

The cost of re-filling evaporator and cylinders will be chargeable to the Hospital Authority.

The manifold shall be located in the open with the liquid plant and shall have a weatherproof covering.

The manifold shall be located in the manifold room as shown on the Contract Drawing Number 1 but shall remain the property of the specialist supplier.

2.3.3. Extent of Specialist oxygen supplier's work, builders work, installation work, insurance

The specialist oxygen supplier shall confirm at the time of commencement of works the following:

1. Supply of drawings and instructions for associated work required to be carried out by others.
2. Identification of pipe work to B.S. 1710 (1971) up to distribution point;
3. Commissioning of plant.
4. Insurance of plant.

2.3.4. Extent of associated work to be carried out by other contractors on behalf of the Health Authority.

The following will be carried out by others (under separate contracts):

1. Provision of access roads to the plant to take road tankers
2. Hard standing pad of non-porous concrete for tanker when filling the plant
3. Drainage of pad and plant foundation by surface fall to drains at least 6meters away.
4. Access road to manifold room where used
5. Electricity supply to suitable agreed distribution point. Wiring from distribution board to control panels on liquid oxygen evaporator and standby manifold and to tanker motor starter box. Wiring from panels to alarm system
6. Electricity supply and lighting equipment to illuminate the plant
7. Fire Protection to Fire Officer's requirements
8. Lighting protection if required,

2.4. MEDICAL COMPRESSED AIR PLANT

2.4.1. General requirements

The specialist contractor shall supply and install at the position shown on contract drawing number 1 a medical compressed air plant having one (Specify either one/two horizontal/vertical air receiver(s) 2000L (each) served by two identical air compressor units and complete with all necessary controls, safety devices, alarms, oil and moisture separators and air dryers.

2.4.2. Quality of Air

The air finally delivered to the ward, room or theatre shall be oil free, dust free and dry as specified later. (Clause 4.21)

2.4.3. Distribution pressure

The pressure in the distribution pipe work shall be initially 7.3 bar +/- 0.15 bar (105 p.s.i. +/- 2.5 p.s.i.) gauge on leaving the plant room, with reducing valve(s) as indicated on the contract drawing(s) to give a pressure of 4.14 bar +/- 0.14bar (60 p.s.i +/- 2 p.s.i) gauge. See clause 4.22 for further details.

2.4.4. Maintenance

The plant shall be designed and arranged to facilitate easy and efficient inspection and maintenance, to the satisfaction of the engineer.

2.4.5. Precautions against vibration and noise

Flexible pipe work connections and resilient mountings shall be provided where necessary to prevent the transmission of vibration and noise to the building and distribution pipe work. The specialist contractor shall be responsible for ensuring that rigid connections are not made either by themselves or others.

2.4.6. Builder's Work

The specialist contractor shall supply and fix all holding down bolts, anti-vibration mountings and supply details of all foundations and hole positions for the building contractor to provide. The concrete foundation block shall be of adequate mass placed on suitable resilient foundations to damp out vibrations.

2.4.7. Air Compressor Unit

2.4.7.1. Definition

Each air compressor unit shall comprise a compressor driven by an electric motor mounted together on a common base plate having anti-vibration mountings.

2.4.7.2. Duty

Each compressor unit shall be identical and have a free air delivery of 4.26 M3 specify) (150.4 cu. ft.) per minute and shall be capable of dealing with the normal load on its own and maintain the gauge pressure in the receiver at 4 bar (+ 0.15 bar) 58.1 p.s.i (+2.1 p.s.i.). The two compressors shall be arranged so that one compressor is on duty while the other is on standby.

2.4.7.3. Type

The compressors shall be of the quadruplex compressor system suitable for continuous operation and having efficient oil seals of proved reliability to the lubricated parts of the machine. (See clause 4.21 for oil mist limit) Compressors with P.T.F.E. rings or seals shall not be allowed because possible overheating would liberate offensive gases from this material.

2.4.7.4. Intercooling and Aftercooling

The compressors shall be of two-stage design with intercooling between stages and final after cooling, so that the air leaving temperature is kept as low as possible in order to reduce condensation and ensure subsequent satisfactory air dryer performance.

2.4.7.5. Safety Valve

The intercooler shall be air cooled by means of fans integral with the compressor and if thought necessary due to warm site conditions the air supply to the fans shall be ducted from outside in order to provide air as cool as possible.

The specialist contractor shall advise on the necessary for ducted air and shall include for any ductwork in their contract.

2.4.7.6. Automatic drain traps

Both intercoolers and aftercooler shall be provided with an automatic drain trap with manual by pass each lea via copper tundishes piped to a suitable gully.

2.4.7.7. Water Cooling

The coolers and cylinders shall be water-cooled and the water supply shall be taken from a storage tank supply in order to ensure that the compressors have a non-interrupted supply. A break tank shall be incorporated between the main tank and the circulating pumps.

2.4.7.8. Storage Tank

A suitable storage tank supply is available and a connection to this system is made at medical plant room by the specialist contractor. A storage tank is to be provided of 2000 litres capacity and is to be included in this contract. The specialist contractor shall make the necessary connections from this system.

2.4.7.9. Water Treatment

The hardness of the local water supply is 35mg/L and local treatment of the water before entering the compressors shall be included in this contract.

2.4.7.10. Non –Recirculated water

The cooling water shall be run to waste via copper tundishes piped to a suitable gully.

2.4.7.11. Re-circulated Water

The cooling water shall be re-circulated and suitable cooling arrangements shall be included in this contract.

2.4.7.12. Circulation Control

The cooling water shall be controlled by a thermostatic immersion on the outflow so that the circulation pump is stopped when a pre-determined low temperature setting is reached. The circulation pump is stopped when a pre-determined low temperature setting is reached. The circulation pump shall be installed in duplicate for study purposes.

2.4.7.13. Thermometers

Thermometers of the dial type shall be provided at the inlet and outlet of points of the coolers to show compressed air temperatures.

2.4.7.14. Excessive Air Temperature Protection

In the event of a higher than normal air exit temperature a thermostat shall switch off the compressor(s) and give warnings as described later. The standby manifold shall then be automatically brought into use.

2.4.7.15. Valves on delivery pipe to receiver.

The two compressors shall supply air to the receiver either through separate delivery pipes or the pipes may join into one common delivery pipe.

An isolating non-return valve shall be fitted on the delivery pipe from each compressor prior to entering the receiver.

2.4.7.16. Air Unloading Valves

Each delivery type shall carry an automatic air unloading valve, prior to the non-return valve; and operated when the compressor stops so that the high-pressure air in this portion of the pipe is released and the compressor can re-start under no conditions. At the manufacturer's discretion this valve may be omitted on compressor can re-start under no load conditions. At the manufacturers discretion this valve may be omitted on the compressors with less than 5.h.p. motors

2.4.7.17. Flexible Pipework

The final connection of the delivery pipe or pipes to the receiver shall be in flexible pipe of "armour" quality, to prevent transmission of vibration from the compressors.

2.4.8. Air Intake Filter

2.4.8.1. Type and Efficiency

The air intake to each compressor shall be through a filter of the dry medium type to B.S 1701 which shall have dust retaining efficiencies of 98% minimum, grade CA, when tested in accordance with that standard.

2.4.8.2. Sitting of Intakes

The sitting of air intakes shall be outdoors in the open at the position shown on contract Drawing Number 2 but if considered necessary the position may be modified

after a final inspection of the site and agreement between the medical officer, the engineer and the contractor, in order to ensure clean air is drawn in.

The length and cross section of the intake shall be approved by the compressor manufacturer to ensure that compressor efficiency is not reduced

2.4.8.3. Weather Protection

The intakes shall be adequately protected by cowls or other means from the ingress of rain, snow, ice and excessive dust.

2.4.8.4. Maintenance

The filters shall be arranged for easy access for maintenance servicing and renewal, to the renewal, to the satisfaction of the engineer.

2.4.9. Air Silencers

The intake filters shall pass the air into silencer assemblies from which the compressors will draw air.

2.4.10. Permissible Noise Levels

The overall effect of silencers, anti-vibration mountings and compressors (both running) shall not produce sound pressures greater than ISO Rating of 75, measured 1.8m away from sides and above the plant.

The contractor shall state the sound pressure levels of the plant being tendered, and this shall be checked and proved on completion of the installation to the satisfaction of the engineer.

2.4.11. Compressor Electric Motor

Each electric motor shall be continuously rated for the maximum duty to be performed and shall be of T.E.F.C. type for 415 volts, 3 phase, 50 hertz A.C. supply and conform to B.S. 2613 and B.S 3979 (metric dimensions) with Class E insulation.

The motor shall drive the compressor either by Vee belts or a flexible coupling, which in either case shall be efficiently guarded to satisfy the requirements of the Factories Act.

2.4.12. Motor starters

Each motor shall have a starter which shall be rated for frequent duty in accordance with B.S 587 and have thermal overload protection.

The starters shall be of the automatic type so that once switched on the motor will be capable of re-starting automatically should the supply be interrupted. This feature shall be indicated by a suitable warning notice displayed on or near the motors. A time delay shall be incorporated to ensure that the two compressors do not start together. Three phase motors shall have single phasing preventers. Each star delta starter shall be electrically and mechanically interlocked to prevent simultaneous star and delta connection.

2.4.13. Ammeter

An industrial grade ammeter to B.S 89 shall be connected in the yellow phase connection to each motor, the dial will be 75mm diameter.

2.4.14. Compressor Controls

2.4.14.1. Duty Selection switch

The two compressors shall run alternately so that one is on duty while the other is on stand by and a changeover duty switch shall be provided so that manual selection can be made.

2.4.14.2. Hour Counter

An “Hour Counter” shall be provided on each compressor to record its total running time and assist in the running time and assist in even running of compressors.

2.4.14.3. Switches

Each compressor shall have a “hand-off-auto” switch to allow choice of either automatic or manual hand control.

2.4.14.4. Pressure switches

The compressors shall be controlled by two pressure switches connected to and sensing the air pressure in the receiver.

The “high” pressure switch shall be set to operate the duty motor starter, when the receiver gauge pressure falls to less than 6 bar (p.s.i.) and to stop the motor when the gauging pressure rises to 8 bar when the compressors are on “hand/manual” control and cut off the motor when maximum pressure is reached.

2.4.15. Control Cabinet

2.4.15.1. Compartment Arrangement

The compressor controls shall be arranged together in one metal cabinet with three separate fireproof compartments. The centre compartment shall contain the duty selector switch, wiring and accessories common to both compressors, while the outer compartments each contain the controls for one compressor and its associated equipment.

A drawing of the panel shall be submitted to the engineer before commencing manufacture.

2.4.15.2. Isolating Switch

The cabinet shall house a load breaking isolating switch interlocked with the cover and the circuits and apparatus shall be protected by H.R.C. fuses.

2.4.15.3. Regulations

Warning notices shall be incorporated for each compartment to warn the presence of medium voltage.

2.4.15.4. Manufacture

The cabinet shall be manufactured from sheet steel, rust proofed (zintec) or electro-coated rust inhibited and not less than 2.0 mm (14s.w.g) thick and adequately braced.

The cabinet shall have an external finish of semi-gloss stoved or cellulose enamel to B.S colour Untreated parts shall have a rust inhibitor coat and an undercoat applied before manufacture. The internal finish shall be white.

2.4.16. Air Receiver

2.4.16.1. Type

Each air receiver shall be of the (specify either vertical/ horizontal type) and have a capacity of 2 m³ (106cu.ft.) of “water” and be designed to conform B.S 487 Part 1, Class 3D. (Fusion welded steel air receivers).

2.4.16.2. Safety Requirements

Each receiver shall be complete with safety valve and fusible plug to B.S 1123 and the safety valve shall be arranged to discharge to a safe position.

2.4.16.3. Inspection, Cleaning and Draining

Each receiver shall have an inspection cover and cleaning outlet, an automatic condensate drain trap with isolating valve and a manual drain valve, both of which shall discharge via a copper tundish piped to a suitable gully.

2.4.16.4. Pressure Gauge

A pressure gauge to B.S 1780 shall be fitted on each receiver, the dial to be 150mm (6”) diameter graduated in bars and p.s.i. to 1 1/2 times working pressure. The gauge shall be complete with isolating valve or cock.

2.4.16.5. Pressure Switch Connections

Provision shall be made on the receiver for tapping to suit the pressure switch connections for compressor control and for standby manifold control.

2.4.16.6. Tests Certificates

The receiver(s) shall have been pressure tested and at the manufacturers works in accordance with B.S 487, part 1 and certificates provided.

2.4.17. Separators and Filters

2.4.17.1. Duty

The air from the receiver shall pass through a separator and filter assembly installed in duplicate, each assembly to be rated for continuous use of the full free air delivery of the compressor, with the air super saturated with water (100% R.H) at the compressor exit air and temperature.

The assembly shall be suitably valved to allow manual selection of either assembly as required.

2.4.17.2. Automatic Drain Trap

Each separator shall be complete with an automatic drain trap, with manual bypass valve, draining via a copper tundish piped to a suitable gully.

The traps shall be capable of dealing with moisture and oil droplets and mist carried over the compressors.

2.4.17.3. Filter Type and Efficiency

When oil free compressors are used, the filters shall be of the oil free dry medium type and have an efficiency of not less than 95% when tested with Test Dust No.2 in accordance with B.S 2831 at the design flow.

When lubricated compressors are used the filters shall have a penetration not exceeding 0.5% when tested by the sodium flame test in accordance with B.S 3928, at the design flow.

2.4.18. Air Dryers

2.4.18.1. Type and duty

The air from the separator and filter assemblies shall pass through a desiccant type air dryer assembly, installed in duplicate and of twin column design, each column being capable of dealing with the maximum flow of air (as 4.17.1) while the other is being dried out.

2.4.18.2. Design

The columns shall be constructed to comply with appropriate requirements for pressure vessels to B.S 487, Part 1, class III D.

The columns shall be designed to facilitate filling with or emptying of desiccant material without the need to disturb pipework connections.

2.4.18.3. Safety Relief Valve. Pressure gauge

Each pair of columns shall be provided with a safety valve to B.S 1780 with dial 100mm (4") diameter, arranged to discharge to a safe position and a pressure gauge to B.S 1780 with a dial 100mm (4") diameter, graduated in bars and psi to 1 1/2 times working pressure. The safety valve and gauge to be fitted beyond the final filters.

The gauges shall be complete with isolating valve or cock. The dials shall be marked with a blue sector showing the working pressure range of the column.

2.4.18.4. Regeneration Process

The regeneration process to drive of the moisture form the saturated column shall be affected by heatless regenerative desiccant dryer through electric heating.

If the electric heating method is preferred, the heating elements shall be designed to give long life and have thermostatic control to prevent overheating.

The heating or drying medium shall be adequate rating so that the time required to dry out a column shall be less than that taken to saturate a column working at full load.

The drying out process shall be controlled so that the heating medium is not used continuously once the column is dry. Heating elements and thermostat elements, if fitted shall be easily removable without disturbing desiccant bed or pipe work connections.

2.4.18.5. Automatic Air Release on Columns

An automatic operated bleed air valve on each column shall allow the column requiring regeneration to release the high pressure via a silencer discharging into copper tundish piped to a suitable gully, one tundish being provided to each pair of columns.

2.4.18.6. Automatic Re-Pressurization of Columns

When the column has been dried out, automatic re-pressurization of it shall follow to prevent shock when change over from the saturated column takes place.

2.4.18.7. Controls

The air dryer assemblies shall be complete with an automatic electric control panel to operate and sequence the valves and change over from one column to the other in a pair.

Change over from one dryer assembly to the other shall be effected by a hand change over switch operating automatic valves to allow either of the assemblies to be selected for duty.

2.4.18.8. Desiccant Material

The dryer columns shall contain activated alumina desiccant of the non-dusty type in pellet, spherical or tablet form. The grade of desiccant shall such that pre-filters to the final filter on the outgoing side of the dryers are not necessary.

2.4.18.9. Desiccant Bed Life

Each dryer assembly, with two columns, shall be designed to provide a desiccant bed life of not less than two years on continuous full load so that the installation comprising of two dryer assemblies shall give a total life of two years when operated on a “duty” and “standby” basis.

2.4.19. Dryness of Air

The dew point of air leaving the dryer shall be minus 400 C (minus 400F) at atmospheric pressure, equivalent to minus 180C (00F) at gauge pressure of 7.3 bar (105 p.s.i)

2.4.20. Final Filter

A filter of the oil free dry medium type shall be fitted on the outgoing side of each dryer assembly. The filters shall have a penetration not exceeding 0.5% when tested by the sodium flame test in accordance with B.S 3928, at the design flow.

2.4.21. Final Condition of Air at Terminal Units

The air delivered to the terminal units shall be free from deleterious, toxic, flammable, objectionable, products, vapours or odours.

A sample of air at standard temperature and pressure shall not contain more than the following substances in accordance with B.S 4275: -

- 0.5 mg /m³ of oil mist particulate.
- 5.5 mg/ m³ of carbon monoxide (5 parts per million)
- 900mg/ m³ of carbon dioxide (500 parts per million)
- dew points as paragraph 4.19

Where sterile air and fine air control is required at the point of use, this is beyond the performance of the plant specified above and will call for additional fine pressure regulators and sterilisable type filters beyond the terminal unit and mounted within the room or theatre. Ensure that the Medical Officers are aware of this.

This equipment is not included in this contract and shall be the subject of a separate contract by the Hospital Authority and thus should be made aware of the same.

2.4.22. Pressure Regulation on Distribution Main

Pressure regulators shall be fitted on the outgoing main, in duplicate for standby purposes, to control the pressure of the air as it leaves the plant room.

The pressure shall be maintained at a gauge pressure of 7.3 bar (105 p.s.i.) \pm 0.15 bar (\pm 2.5.p.s.i.)

The pressure shall be reduced along the system at the positions indicated on the contract drawing(s) number (s) specify the drawings no's) 1 – 6 to gauge pressure of 4.14 bar (60 p.s.i.) \pm 0.14 bar (\pm 2 p.s.i).

2.4.23. Pressure Gauge and Safety Valve on Distribution Main.

One the pressure gauge and one safety relieve valve shall be fitted on the outgoing main following the pressure regulating valves. They shall be of the type and size as described for the receiver vessel. The relief valve shall be vented via copper pipework to a safe position.

2.4.24. Standby Air Cylinder Manifold

2.4.24.1. Location

The specialist contractor shall supply and install in the medical air plant room 1 a Standby Medical Quality Air Cylinder Manifold which shall come into operation automatically should the compressed air plant fail.

The ordering of the initial full complement of cylinders and any future replacement cylinders shall be the responsibility of the Hospital Authority.

2.4.24.2. Capacity

The cylinder supports and headers shall comprise of two banks each with 5 cylinders of 47 litres (1.66 cu.ft.) capacity. A stand by supply of one day is recommended.

One bank shall be on duty while the other is on standby.

2.4.24.3. Standby Operation

The standby manifold shall come into operation for any of the following reasons: -
Compressors faulty – not maintaining pressure- air temperature too high. Dryer faulty- dew point high. Line pressure 15% below normal.

2.4.24.4. Manifold Assembly

The requirements of the Standby Manifold shall be as described for medical gas manifolds covering: -

- Manifold headers
- Non-intercheablility of cylinder connectors
- Testing of headers
- Degreasing

Control Panel with: -

- Either Automatic Operation for “changeover” Or Manual Operation for “changeover” (specify)
- Pressure gauges
- Identification

2.4.24.5. Electricity Supply

The standby manifold shall be suitable for operating from a 240volt, single phase/ 3 phase / and neutral, 50 hertz, A.C. supply.

2.4.24.6. Connection Point into Distribution System

The air, which will be of the correct quality and dryness, will not require further filtering or drying and the standby supply shall be permanently connected into the distribution main in the plant room at a point beyond the pressure gauge and safety valve at the plant room wall.

A non-return valve shall be fitted prior to the above gauge and relief valve to prevent back pressure to the dryers, etc. from the cylinder supply.

A stop valve shall be provided to allow the standby connection to be isolated.

2.4.24.7. Electrical Installation Work

All electrical equipment shall be supplied and installed by the Specialist Contractor.

The interconnecting wiring shall be carried out to separate specification by the Specialist Contractors /others.

The specialist Contractor shall in all cases supply duplicate wiring diagrams and instructions within 4 weeks of being awarded the contract.

2.5. MEDICAL VACUUM PLANT

2.5.1. General Requirements

The Specialist Contractor shall supply and install at the position shown on the Contract Drawing No 1 a Medical Vacuum Plant having (specify either one/ two/ horizontal/ vertical reservoir vessels(s)) (each) served by two identical vacuum plant units and complete with all necessary controls, drainage traps and bacterial filters. Discharge into an aerobics septic chamber is not permissible due to potential health hazards.

2.5.2. Degree of Vacuum

The overall design of the system shall be such that the degree of vacuum in the distribution pipework at the back of the remotest terminal unit is not less than 400mm Hg below a standard atmospheric pressure of 760 mm Hg (360 Hg absolute).

2.5.3. Total Design Flow

The total design flow of the system shall be 4260litres of free air per minute minimum.

2.5.4. Maintenance

The plant shall be designed and arranged to facilitate easy and efficient inspection and maintenance, to the satisfaction of the engineer.

2.5.5. Precautions against Vibrations and Noise

Flexible pipework connections and resilient mountings shall be provided where necessary to prevent the transmission of vibration and the noise to the building and distribution pipe work.

The specialist contractor shall be responsible for ensuring that rigid connections are not made either by themselves or others.

2.5.6. Builder's Work

The specialist contractor shall supply and fix all holding down bolts, anti-vibration mountings and supply details of foundations and hole positions for the building contractor to provide. The concrete foundation block shall be of adequate mass placed on suitable resilient foundations to damp out vibrations.

2.5.7. Vacuum Pump Unit

2.5.7.1. Definition

Each vacuum plant unit shall comprise a vacuum pump driven by an electric motor mounted together on a common base plate having anti vibration mountings.

2.5.7.2. Duty

Each vacuum plant unit shall be identical and have a capacity of 1280 litres /minute of free air equivalent to a volumetric through output of 1280 litres per minute at a vacuum of minus 450mm Hg (450 mm Hg absolute).

The two vacuum pumps shall be arranged so that one pump is on duty while the other is on standby and each shall be capable of dealing with 75% of the total design flow and running continuously at this load.

2.5.8. Water Sealed Pumps

The pumps shall be of the water sealed type and the water supply shall be from a break tank situated to provide the necessary head on the seal water lines.

A self- cleaning strainer shall be from a storage tank in order to ensure that the pumps have a non- interrupted supply.

2.5.8.1. Water Supply

The water supply to the break tank shall be from a storage tank in order to ensure that the pumps have a non-interrupted supply.

2.5.8.2. Storage Tank

A suitable storage tank supply is available and a connection to this system is to be made at medical plant room by the Specialist Contractor.

A storage tank is to be provided of 1500litres capacity and is to be included in this Contract. The Specialist Contractor shall make the necessary connections from this system.

2.5.9. Vacuum Pump Exhaust System

2.5.9.1. Silencers

The discharge from the vacuum pumps shall pass through silencers in order to keep the noise level down to a minimum. (See also 5.10.5)

2.5.9.2. Location of discharge pipes

The discharge pipes shall terminate outdoors at high level at the position shown on the Contract Drawing but if considered necessary the position may be modified after a final inspection of the site and agreement between the Medical Officer, the Engineer and the Contractor in order to ensure that the discharge cannot constitute a health hazard.

2.5.9.3. Weather protection

The discharge of pipes shall be adequately protected by cowls or other means from the ingress of rain, snow, ice and wind pressure and sited away from windows and air intakes.

2.5.9.4. Back Pressure

The exhaust system shall be designed so that the back pressure does not exceed 50 mm Hg (1.0 p.s.i) at the peak demand and this figure shall be taken into account when sizing the pumps.

2.5.10. Permissible Noise Levels

The overall effect of silencers, anti-vibration mountings and pumps (both running) shall not produce sound pressure greater than I.S.O rating of 75, measured 1.8 m (6 feet) away from sides above the plant.

The Contractor shall state the sound pressure levels of the plant being tendered and this shall be checked and proved on completion of the installation to the satisfaction of the Engineer.

2.5.11. Vacuum Pump Electric Motor

Each electric motor shall be continuously rated for the maximum duty to be performed and shall be of T.E.F.C type for 440volts, 3phase, 50-hertz a.c. supply and conform to B.S 2613 and B.S 3979 (metric dimensions) with class e insulation.

The motor shall drive the pump either by vee belts or flexible coupling, which in either case shall be efficiently guarded to satisfy the requirements of the Factories Act.

2.5.12. *(25) Motor Starters

Each motor shall have a starter which shall be rated for frequency in accordance with B.S. 587 and have a thermal overload protection.

The starters shall be of the automatic type so that once switched on the motor will be capable of re-starting automatically should the supply have been interrupted. This feature shall be indicated by a suitable warning notice displayed on or near the motors. A time delay shall be incorporated to ensure that the two pumps do not start together. 3 phase motors shall have single phasing preventers. Each star delta starter shall be electrically and mechanically interlocked to prevent simultaneous star and delta connection.

2.5.13. Ammeter

An industrial grade ammeter to B.S 89 shall be connected in the yellow phase connection to each motor, the dial to be 75mm diameter.

2.5.14. Vacuum Pump Controls

2.5.14.1. Duty Selection Switch

The two pumps shall be run alternatively so that one is on duty while the other is on standby and a change-over duty switch shall be provided so that manual selection can be made.

2.5.14.2. Hour Counter

An hour counter shall be provided on each pump to record its total running time and assist in even running of the pumps.

2.5.14.3. Switches

Each pump shall have a “hand/manual-off-auto” switch to allow choice of either automatic or hand/manual control.

2.5.14.4. Pressure Switches

The pumps shall be controlled by two pressure switches connected to and sensing the vacuum in the reservoir.

The “high” pressure switch shall be set to operate the duty motor starter when the reservoir gauge pressure falls tomg Hg and to stop the motor when the gauge pressure rises tomm Hg.

The “low” pressure switch shall be set to operate the standby motor starter when the reservoir gauge pressure falls tomm Hg and to stop the motor when the gauge pressure rises tomm Hg.

When the pumps are on hand control and cut-off the motor when maximum working vacuum is reached.

2.5.15. Control Cabinet

2.5.15.1. Compartment Arrangement

The vacuum plant controls shall be arranged together in one metal cabinet with three separate fireproof compartments.

The centre compartment shall contain the duty selector switch, wiring and accessories common to both pumps, while the other compartments each contain the controls for one pump and its associated equipment. A drawing of the panel shall be submitted to the Engineer before commencing manufacture.

2.5.15.2. Isolating Switch

The cabinet shall house a load breaking isolating switch interlocked with the cover and the circuits and apparatus shall be protected by H.R.C fuses.

2.5.15.3. Regulations

Warning notices shall be incorporated from each compartment to warn the presence of medium voltage, to conform to I.E.E regulations A.17 and A.19.

2.5.15.4. Manufacture

The cabinet shall be manufactured from iron sheet, rust proofed (Zintec) or electro-coated rust inhibited and not less than 2.0 mm (14 S.W.G) thick and adequately braced.

The cabinet shall have an external finish of semi-gloss stoved or cellulose enamel to standards. Untreated parts shall have a rust inhibitor coat and an undercoat applied before manufacture.

The internal finish shall be white.

2.5.16. Vacuum Reservoir Vessel

2.5.16.1. Type Design

Each Vacuum Reservoir Vessel shall be of the vertical/ horizontal (specify) type and be designed to conform to B.S 487, Part 1, Class III D (Fusion Welded Steel Air Receivers).

2.5.16.2. Capacity

The capacity of the vessel shall be 1500litres “water capacity”.

The capacity is intended to be such that the number of start/ stop cycles of the pump on duty does not exceed 30times per hour.

2.5.16.3. Safety Requirements

Where inadvertent reversal of the pump motor could occur on 3 phase supply, a pressure switch on the inlet pipe between reservoir and pump shall switch off the motor on sensing a positive pressure. A non-return valve shall also be fitted as a further safeguard.

2.5.16.4. Inspection, Cleaning, Draining

The reservoir(s) shall have an inspection cover, a cleaning outlet and a manual drain valve which shall discharge via copper tundish piped to a suitable gully.

2.5.16.5. Vacuum Gauge

A vacuum gauge to B.S 1780 shall be fitted on each reservoir, the dial to be 150 mm (6") diameter, calibrated 0-760 mm HG and reading Zero (0) at atmospheric pressure.

The gauge shall be complete with isolating valve or cock. The dial shall be marked with a blue line at the normal working vacuum and a red line at the minimum allowable vacuum.

2.5.16.6. Pressure Switch Connections

Provision shall be made on the reservoirs for tappings to suit the pressure switch connections for vacuum pump control.

2.5.16.7. Tests Certificates

The reservoir(s) shall have been pressure tested at the manufacturer's works in accordance with BS 487 Part I to 10.3 bar (150 p.s.i.) gauge.

2.5.17. Drainage Traps

2.5.17.1. Duty

The intake to the vacuum vessel from the distribution pipeline shall first pass through a drainage trap, installed in duplicate, each trap being sized to deal with the total maximum flow.

2.5.17.2. Sterilizing

The bowls of the traps shall be sterilisable by the following methods: -

- (a) By means of moist steam at 2.2 bar gauge (32 p.s.i.) and 1380C (2800F) in a porous load sterilizer to B.S 3970.
- (b) By means of dry heat at 1600C (3200F) for at least 60 minutes.

The trap bowls shall either be transparent or have transparent windows.

2.5.17.3. Spare Trap Bowls

Two sets of spare trap bowls shall be included initially to cater for frequency of sterilizing required and to ensure that a sterilized set is available always for change-over purposes.

2.5.18. Bacterial Filters

2.5.18.1. Duty

A bacterial filter shall be fitted between each drainage trap and vessel, each filter being capable of dealing with the total maximum flow.

The filter housing shall be distinctly marked with the words "BIO-HAZARD".

2.5.18.2. Efficiency

The penetration of the filters when tested by the sodium flame test in accordance with B.S 3928 shall not exceed 0.05% at the design flow.

2.5.19. Operations of Traps and Filters

The traps and filters shall be operated on a duty and standby basis and manually operated valves shall be provided so that either of the sets can be selected and to allow for isolation for maintenance and changing of trap bowls and filters.

2.5.20. Standby Vacuum Facilities

Standby Emergency Vacuum Facilities are not covered under this contract. An emergency service from portable electric suction apparatus to BS 4199 should be arranged by the Hospital Authority.

2.5.21. Electrical Installation

All electrical equipment shall be supplied and installed by the Specialist Contractor. The interconnecting wiring shall be carried out to separate specification by the Specialist contractor / others.

The specialist contractor shall in all cases supply duplicate wiring diagrams and instructions, within 4 weeks of being awarded the contract.

2.6. DISTRIBUTION PIPEWORK SYSTEM

2.6.1. Extent of Pipework

The Specialist contractor shall supply, install, connect up and test all the pipework and valves required from the supply source to the distribution terminals for each gas, air and vacuum.

The pipe sizes and valve positions shall be as given on the Contract Drawings and test procedure as described later.

2.6.2. Pipe Installation

2.6.2.1. Fixing

All pipework shall be fixed without any springing or forcing. A clearance of 150mm (6") shall be maintained between the pipework and other services. Where pipework crosses other services a clearance of 25mm (1") minimum shall be maintained.

2.6.2.2. Gradients

Gradients are not required on gas, air or vacuum pipelines.

2.6.2.3. Drainage

A full way drain lock is to be provided at the bottom of each main vertical run on the air and vacuum pipework.

Branches on horizontal air pipe work shall be taken from the topside of mains to avoid pockets of moisture.

2.6.2.4. Diversion Sets

The use of fittings for the diversion sets shall not be permitted and the sets shall be formed from a long length in one piece and cold drawn or hot drawn in a neat manner without bucking or thinning.

2.6.2.5. Routing to avoid Fire Risk Areas

The routes of the pipework shall avoid fire risk areas including laundries boiler houses, generator rooms, incinerator rooms, storage rooms for combustible materials (unless the pipes are to be cased), lift shafts and kitchens.

2.6.2.6. Pipework Supports

Pipework shall be supported at not greater than the intervals shown in the table below:

SPACING OF SUPPORTS FOR COPPER PIPES

Nominal Pipe outside diameter mm BS 2871

Part 1 Table X Maximum Intervals

For Vertical Runs Maximum Intervals

For Horizontal Runs

Metres Metres

10	1.2	-
12	1.2	1
15	1.8	1.2
18	2	1.5
22	2.4	1.8
28	2.4	1.8
35	3	2.4
42	3	2.4
54	3	2.7
76.1	3.6	3

Where valves are fitted the pipe shall be supported at both sides of the valve to facilitate valve operation without valve movement.

Fixing brackets or supports shall be of a suitable non-ferrous material or suitability treated to minimize corrosion and prevent electronic action.

The specialist contractor shall drill and plug walls and ceilings as required fastening the supports. Where roof decking is encountered the specialist, contractor shall provide cavity fixing devices to fasten the supports.

2.6.2.7. Pipework in Floors, Walls, Ceilings

Pipework in rooms and corridors shall be concealed either behind ceiling panels, or in walls, ducts or trucking. Removable covers or panels shall be provided to allow access to pipework.

Pipework shall not be buried solidly in floors, walls or ceiling except with the approval of the Engineer. Approval will normally be given only for tail pipes in one piece from Terminal unit to service duct or ceiling void and for unjointed pipes from control valve to void. The route of the buried pipe should be clearly and continuously marked by chalk, coloured adhesive tape or otherwise, during construction, to discourage the driving of nails into or near the pipe. Where pipes are to be installed in partition walls the tail pipes of terminal unit shall be in one piece (without joint) from the terminal unit to the service duct ceiling void.

Service ducts or voids should have adequate ventilation to prevent gas concentration in the event of a leak.

Where pipes pass through floors, walls or partitions, copper sleeves shall project between 1.5 and 3mm (1/16" and 1/8") beyond finished surfaces and plates shall be fitted. All joints shall be accessible, and no joint shall be made so that it's inside the pipe sleeve.

Where pipework is to be concealed it shall not be covered over until it has satisfactory passed all pressure tests.

Pipework in service ducts, or voids or in rooms or in corridors where the pipework is not required to be concealed shall be surface run.

2.6.2.8. Special Precautions against Corrosion.

Where pipework is supported by or is liable to come into contact with timber that has been treated with compounds likely to cause corrosion of copper, the pipe shall be protected locally by impermeable materials such as p.v.c. tape or spacers.

2.6.2.9. Cleanliness during installation

Great care shall be taken during installation to ensure that no extraneous materials are allowed to enter the pipework. Where any section of the pipework is left incomplete during erection the open end of the pipe shall be sealed immediately with plastic cap.

2.6.2.10. Bonding and Earthing

Wherever possible, pipeline shall be physically separated from the metal sheath and armour of electric cables and from metal conduits, trunking and bare earth continuity conductors associated with any cables which operate at low voltage or above.

Where physical separation is impossible or when pipeline is in metal trunking and bed head units the pipeline shall be bonded to the I.E.E Regulations B. 53 and D.10.

The above work shall be carried out by specialist contractor or other.

2.6.3. Pipework Material and Size

2.6.3.1. Material

Pipework material for gases, air and vacuum shall be phosphorous de-oxidized non-arsenical copper to B.S 1172

2.6.3.2. Sizes

Pipework sizes shall be to metric outside diameters in accordance with B.S. 2871, Part 1, Table X.

2.6.4. Fittings and Joints

2.6.4.1. Capillary Fittings

All fittings shall be “high Duty” Capillary Type suitable for a “steam” working pressure of 17bar (250p.s.i.) gauge.

The fittings shall have integral rings of silver brazing alloy complying with composition to B.S 1845 (1966) Table 2, Type AG.11 Brazing by the end-feed method shall not be permitted.

The fitting shall be non-ferrous and capable of withstanding corrosion and dezincification.

2.6.4.2. Flux

Because of the high temperatures required for their effective use borax or borax-based fluxes shall NOT be used.

The flux shall be provided by the Fitting Manufacture to suit the work. Fluxes shall be free from grease and agents which promote corrosion or deposits of chlorides. Care shall be taken to avoid any excess of flux which might enter the pipe bore and when the joint is cool excess flux shall be washed and wire brushed off. A visual inspection of each brazed joint shall be made to confirm that the hardened flux has not formed a temporary seal which holds test pressure.

2.6.4.3. Fittings

Fittings on moisture eliminators and trap sets for vacuum and compressed air shall be brass competition type fittings, or flanged fittings as appropriate.

2.6.4.4. Valve Joints. Capillary or Screwed

Joining of valves to the pipelines shall preferably be made with a capillary joint similar to 6.5.1. but the end feed method may have to be used in this case. *(57). If, however, the valve connection is screwed a capillary to screwed adaptor shall be used but in this case the joint shall be made by tinning the male thread with soft solder. Litharge and Glycerin or an approved oxygen lung or scaling compound are also acceptable. See also 6.7.1.

The screwed joint shall be factory made using silver alloy as specified for capillary fittings and the adaptor screwed up while the “tining” is molten. This shall be done with valves dismantled to avoid damage to internal parts and the same care shall be taken when making the capillary to the damage diaphragms, seating etc.

The parts of the valves shall be maintained in a degreased condition. Screw threads shall be tampered either to B.S. 3643 or BS. 21. Parallel threads shall not be used.

2.6.5. Degreasing of Pipes and Fittings

2.6.5.1. Extent. Protection Labelling

All pipework and fittings for medical Gas, air and vacuum shall be degreased at the manufacturer’s works, the pipes to be individually fitted with purpose made tightly fitting plastic caps or plugs to protect the bores before dispatch to site. Pipes shall be delivered in bundles in protective wrappings and fittings in sealed polythene bags, no capping required.

The bundles and bags shall be securely and clearly labelled: - “Degreased Materials”. For use on Medical Gas Installations. Do not allow to come into contact with oil or grease”.

The specialist Contractor shall take great care in storing these materials and any materials contaminated while on site shall be returned to the manufacturer for degreasing, all at the expense of the Specialist Contractor.

2.6.5.2. Degreasing Processes

The pipes shall be degreased internally by steam, then dried, shot blasted and blown through with medical quality bottled air. After a visual inspection each pipe shall be capped individually at both ends.

If steam cleaning is not economical, pipes above 54mm outside diameter may be alternatively cleaned using an approved solvent such as such as methyl chloride, which will leave no poisonous or explosive residues and the fittings shall be dried out, inspected and capped or sealed as specified in 6.6.1.

While the degreasing process is primarily concerned with the bore of pipes care shall be taken to avoid oil or grease on the outside, as being a possible source for bore contamination t occur from.

Degreasing of valves is dealt with under 6.7.4.

2.6.6. Valves on Distribution Pipework

The Specialist Contractor Shall supply and fit valves at the positions shown on the Contract Drawings and any deviations from these positions shall be agreed in writing by the Engineer.

The height of valves is to be stated under “Valve Boxes”, (6.8.3.) but in plant or manifold rooms valves may be arranged differently providing they are easily accessible for emergency or maintenance use.

2.6.6.1. *(59) Valve Materials and Types

All valves shall be of non-ferrous material and of the non-lubricated type, to the following details. If screwed, threads shall be tampered either to BS.3643 or BS.21 (see 6.5.4.) Parallel threads shall not be allowed.

a) Medical Gas Valves (specify)

Type
Bores
End Connections
Manufacture

b) Compressed Air valves (specify)

Type
Bores
End Connections
Manufacture

c) Vacuum Valves (specify)

Type
Bores
End connections
Manufacture

2.6.6.2. Direction of Valve Closure

Wheel screw valves shall close in a clockwise direction. Lever Ball Valves shall have the direction of closing indelibly cast or engraved on the wheel by means of an arrow and the word “CLOSE”.

Lever ball valves shall have “ON” / “OFF” cast or engraved on to show when the valve is open or closed.

2.6.6.3. Maker’s Identification

Each valve shall carry the manufacturer’s serial numbers or identification and valve size.

2.6.6.4. Pressure Testing and Degreasing

All valves shall be pneumatically tested by the manufacturers to twice the working pressure and afterwards de-greased for medical gas services using a suitable method as given as at 6.6.2 before being individually sealed in polythene bags, capping not required.

The valves shall be securely and clearly labelled: -

“Degreased Valve. For use on Medical Gas installations. Do not allow to come into contact with oil or grease”.

2.6.6.5. Certificates

A certificate shall be supplied by the manufacturer for each valve or batch stating that pressure tests and degreasing has been carried out and that any solvents have been completely removed.

2.6.6.6. Valves for System Testing Purposes

The Specialist Contractor Shall Supply and fit at the position(s) shown on the Contract Drawings (s), a three-valve arrangement to facilitate providing and testing of the installation(s).

The Principle of the method is shown on schedule No.6 and the procedure laid down under Testing and Commissioning Requirements. The valves shall be of non-ferrous material, de-greased and comply with relevant requirements, as previously specified and to be to following details: -

- Type
- Bores
- End Connections
- Manufacture

The valves shall be suitably labelled as described under 6.10

2.6.6.7. Extended. Phased. Modified, Installations

New work during installation shall be physically separated from the existing system and final joining up left to the last after completing all tests in section 10.

2.6.7. Valve Boxes

2.6.7.1. Location

The Specialist Contractor shall supply and install lockable valve boxes for all the medical gas, air and vacuum valves located outside manifold and plant rooms and not contained in ducts or cupboards etc.

2.6.7.2. Purpose

The boxes shall render the valves tamper proof and shall have a transparent breakable panel to facilitate emergency operation of the valve.

2.6.7.3. Mounting Height

The valves shall serve for the both emergency and maintenance purposes and because of the former requirement the box and valve shall be mounted at the centre height of 1.22metres (4 feet) above floor level in a position not obstructed in a anyway by other equipment. Boxes for the different gases grouped together may be fixed one above another in which case the mean height is to be 1.22m.

2.6.7.4. Mounting Depth

The boxes shall be set into the wall with any projection being kept to a minimum and surface mounted boxes shall be avoided if at all possible. The Specialist Contractor shall ascertain from the Architect or Site the nature of the wall into which the boxes will fit.

2.6.7.5. Standardised Type Boxes

The design of box offered shall be of a standardized pattern throughout the installation and have the following features:

- (a) Ease of access for fitting valve and maintenance
- (b) Designed so that the pipework can be fitted easily, either by having a split box or other suitable means
- (c) Ventilation to obviate a possible build-up of gas in case of a leak,
- (d) Non-interchangeable keys so that a maintained permit – to – work system can be operated
- (e) Keys in duplicate
- (f) Keys and locks with numbers engraved on
- (g) Breakable transparent panel
- (h) Non-interchangeability box covers if this could wrongly identify – covers to be hinged on.
- (i) Boxes shall accommodate one valve only, ganging not permitted.

2.6.7.6. Box Material

The boxes shall not be of wooden construction but of robust plastic or metallic material and capable of withstanding hazards from blows, abrasions and fire.

The finished appearance of the boxes shall be such that they match the décor of the rooms and are not unsightly.

2.6.8. Valves in Ducts or Cupboards

The valves shown on the Construct Drawings in ducts or cupboards are intended for maintenance purpose only and are not required to be in valve boxes, providing the valves are lockable in the open and closed position. Suitable locking arrangements and duplicate non-interchangeable keys shall be provided so that such valves can be included in any permit to work scheme. (See 6.8.5.d.).

Care shall be taken not to install valves in cupboards or ducts which are poorly ventilated or in cupboards used for other materials which could be affected by leakages. Any pipe runs so situated shall be drawn to the attention of the Engineer before proceeding on site.

2.6.9. Identification of Valves

An engraved label of white “Traffolyte” or similar material shall be permanently fixed adjacent to each valve box to indicate the service and give the following information:

- | | | |
|----|--|--------------------|
| a) | In Red Letter | Engraving Required |
| | 1. Service | e.g. “OXYGEN” |
| | 2. Area Served | e.g. ‘WARD 1’ |
| 3. | Emergency Instruction e.g. “IN EMERGENCY BREAK
PANEL AND CLOSE VALVE” | |
| b) | In Black letters: | |
| 1. | Valve number | e.g. “VALVE 6” |

This number is for maintenance purpose and is to be agreed later on site.

Valves in ducts or cupboards shall be similarly identified except for emergency instructions.

The titles of areas served shall be finally agreed on site and the labels shall be installed before the systems are tested and commission in order to prove their correctness.

2.6.10. Terminal Units

2.6.10.1. Extent of Works

The Specialist Contractor shall supply, install and connect to the distribution pipework all the terminal, install and connect to the distribution pipe work all the terminal units required at the positions shown approximately on the Contract Drawings and as listed on the Schedule of Terminal Units.

2.6.10.2. Definition

A terminal unit shall be defined as a single outlet point for a specific gas shall be a separate unit for that one gas only.

2.6.10.3. Fascia Plate

Terminal Units for different gases at one location may be house under a common fascia plate but it shall not be possible to amount the fascia plate incorrectly and reverse or alter the identification of the services. The Units should be mounted on a common back plate to ensure accurate centering of the units and allow precise fitting of the fascia plate so that the probes enter freely.

2.6.10.4. Mounting Order

The Terminal Unit when viewed facing the units shall be mounted in the following order horizontally from left to right: -

Oxygen. Nit: Oxide. Nit Oxide/Oxy: Mixture Carbon Dioxide. Compressed Air. Vacuum.

2.6.10.5. Type (select either as required)

The terminal units shall be of the flush mounted type set into the wall. Or the Terminal units shall be of the raised surface mounted type with probe connection made vertically underneath.

2.6.10.6. Mounting Height

The mounting height of the terminal units above floor level shall be as follows: -

- a) For Flush Mounted Units 1.3m (4' - 4") to centre of Unit
- b) For Raised Surface Mounted Units 1.6m (5' - 2") to centre of unit
- c) For "Rail" Systems areas 1.5m (5'-0") to centre of unit.*(65a)

2.6.10.7. Exact Positioning of Terminal Unit

The exact position of the terminal units relative to the beds, operating tables, etc. shall be finally agreed between the Medical Officers and Architect/Engineer, and the Architect/Engineer shall provide the Specialist contractor with suitable drawings.

Due regard shall be given to ensure that nursing stall can couple up equipment easily, the short for flexible pipes to apparatus can be achieved without obstruction movement to staff or equipment round the patient and the access to the units for maintenance is easy without disruption to patients or other services.

2.6.10.8. Essential Design Features of Units

Terminal Units shall be designed to incorporate the following features: -

- (a) The ability to accept, retain and release the inserted probe by means of a quick release mechanism designed for single handed operation.
- (b) A secondary locking mechanism to prevent accidental ejection of the probe which is to be finally removed by hand.
- (c) Two Valves: -
 - i. A valve on the inlet to the unit which can be closed to isolate the unit only, without the need to isolate a complete section when maintenance is carried out.
 - ii. A self-sealing check valve which is opened by the probe and or withdrawal closes before secondary lock engages.
- (d) Non-swivel type terminal socket to probe connection so that secondary equipment such as a flow meter is not tilted during use.
- (e) The terminal socket and check valve shall only accept the correct probe for the specified "gas" and not allow inter-changeability with or partial operation by probes for any other service.
- (f) It shall not be possible to interchange the parts of a unit for one gas with those for a different gas and so enable a probe to be connected to the wrong position.

- (g) Fascia plates which is such that interchangeability of fascia plates between the different gas terminal units is impossible.
- (h) The front face around the terminal socket to be exposed and to carry “gas” name and colour identification, unless incorporated as at 6.11.8(7).
- (i) Identification by shape incorporated on the problem is not an essential feature but if adopted by a manufacturer the following shapes shall be used:

Service	Shape
Oxygen	Hexagonal
Nitrous Oxide	Round
Nitrous Oxide /Oxygen Mixture	Round with two opposing flats
Carbon Dioxide	Triangular with radiused corners
Medical Air	Round with one flat
Medical Vacuum	Square

2.6.10.9. Identification Colours and Wording on Units

The following names and colours shall apply:

Service	Colour	Wording
Oxygen	White	Oxygen
Nitrous Oxide	French Blue	Nitrous Oxide
Nitrous Oxide/Oxygen Mixture	French Blue and white quarters	N ₂ O+O ₂ (50/50)
Carbon dioxide	French Grey	Carbon dioxide
Medical Air	White and Black Quarters	Medical Air
Medical Vacuum	Prim Rose	Vacuum

The name and colour shall be permanent, and it shall not be possible to transfer either to a different terminal.

Painting on of colour or wording is not permissible.

2.6.10.10. Pressure Loss across Terminal Units

The terminal units shall be capable of passing the following flow rates without exceeding the stated pressure losses across the terminal units.

Nominal Gauge Pressure at back of Service	Terminal Unit		Maximum Rate Maximum permissible of flow required		loss across terminal unit	
			at this pressure			
Bar	p.s.i.	Litre/min.at STP		bar	p.s.i.	
Medical Gases	3.93	57	40		0.034	0.5
NitrousOxide/ Oxygen Mixture	3.93	57	275		0.55	8

Medical Air	6.9	100	250	0.34	5
Medical Vacuum	Minus 400mm Hg (360 mmHg absolute)		40	100mm Hg	

The figures relate to the performance required of the terminal units.

The actual design flow rates for purposes of sizing the installation and determining pipeline diameters should be taken from Section V of HTM 22.

2.7. SPECIAL FITTINGS FOR OPERATING THEATRES

2.7.1. Location and Type

The Specialist Contractors shall supply, install and connect to the distribution pipework in each operating Theatre. These fittings are in addition to the wall mounted terminal units specified earlier.

2.7.2. Gases to be dispensed

The fittings(s) shall supply the following “gases”:-
Oxygen, AGSS, nitrous oxide and medical air.

2.7.3. Design of fittings

2.7.3.1. Boom Assembly, Open Type A

The boom shall be designed to carry flexible pipes connected into standard type flush fitting terminal units mounted at a height of 1.8M (5'-11”) above floor level.

2.7.3.2. Boom Assembly, Enclosed Type B

The boom shall be designed to carry concealed pipes of nylon connected to the distribution Pipework in a suitable wall unit.

2.7.3.3. Ceiling Pendant, Multipoint, Type C.

The pendant shall comprise a heavily chromed or stainless steel removable ceiling rose through which flexible hoses with terminal end connections are suspended.

The connections to the distribution pipework shall be within the ceiling rose space and the design shall be such that all strain is taken off the hose connections

The hose to distribution pipe connections shall not be interchangeable between the different services.

2.7.3.4. Ceiling Pendant, Single Point, Type D

The Pedant shall comprise a heavily chromed or stainless steel removable ceiling rose through which a flexible hose with terminal end connection is suspended.

The connection to the distribution pipe shall be within the ceiling rose space and the design shall be such be that all strain is taken off the hose connection.

2.7.3.5. Terminal Connections

The terminal connection on all fittings shall only accept standard type probes and shall incorporate all the necessary features of the wall mounted terminal units as regards non-interchangeability, self-sealing check valves, isolating valves, identification.

2.7.3.6. Valves

Where the design of the terminal connection on the fitting or hose does not include an isolating valve, this shall be provided elsewhere weather within or near to the fittings on the incoming distribution pipe work, in any easily assessable position for maintenance purposes.

2.7.3.7. Special Precautions

The design of all special fittings and hoses shall ensure that during use and movement of the fitting the pipework or hose cannot be twisted, kinked, uncoupled at either end, overstrained or otherwise damaged.

2.7.3.8. Anti-static Precautions

All fittings and hoses shall be of anti-static construction.

2.7.3.9. Cleanliness

All fittings shall be designed to present minimum lodgement of dirt, dust, etc. and be easy to keep clean. The materials of construction shall have complete freedom from rusting, scaling or deterioration and may be enamelled finish, stainless steel, or heavily chromed finish.

2.7.3.10. Order of Arrangement of Terminal Connections

On multi-point fittings the order arrangement of the terminal connections shall be as follows: - Oxygen. Nit: Oxide. Nit: Oxide/ Oxy: Mixture. Carbon Dioxide. Comp.Air. Vacuum

For pendants and columns, the above order clockwise nearest to the hinge.

2.7.3.11. Headroom Clearance

All fittings shall provide a minimum clearance of 1.8m (5'-11") above floor level and on telescopic fittings when in the retracted position.

2.7.3.12. Dimensions of Fittings

The terminal outlet connections of fittings shall not be more than 1.9m (6'-3") above floor level on booms, pedant hoses and columns.

The depth of fittings and pendant hose length shall suit the height of the room.

These dimensions shall be verified on site by the specialist Contractor.

2.7.3.13. Structural Requirements for fittings

The specialist contractor shall state in his tender the requirements for structural strength of walls or ceilings to which the special fittings are to be fastened.

2.7.3.14. Positioning of Special Fittings

The exact positioning of special fittings shall be agreed between the Medical Officers and Architect, and the Architect shall provide layout drawings for the Specialist Contractor.

2.7.3.15. Electrical Services in Fittings

The bedhead unit shall carry electrical services which shall be in solid drawn rust-proof conduit separate from the medical service pipes.

The electrical fittings shall be arranged in a neat manner to fit in with the medical terminal outlets and shall afford easy access for coupling up equipment.

2.8. IDENTIFICATION OF PIPELINES

2.8.1. Permanent Identification

The Specialist Contract shall carry out identification of the installations(s) by colour coding in accordance with Data Sheet EE 10.11/12 and B.S. 1710 (1971).

The identification shall comprise: -

- a) Colour handing applied at valves, junctions; either side of walls, floors and at intervals of about 2m (6 feet) on short runs up to 4m (13 feet) on long straight runs).
- b) The name of the service printed on the colour hand in a contrasting colour.
- c) An arrow at each colour band showing direction of flow.

Letters to be a minimum of 6mm (¼") high.

Self-adhesive plastic labels or tapes of approved manufacture may be used as an alternative to painting. Where valves are in a valve boxes and identified by "Traffolyte" labels, colour handing is not required.

2.8.2. Temporary identification

During installation of piping, individual pipes, valves junctions and ends shall be identified as the work progresses. This identification shall be at intervals similar to final identification requirements and may be made with removable labels. These temporary identification labels must be subsequently replaced by the permanent ones at an appropriate stage.

2.9. WARNING AND ALARM SYSTEMS

2.9.1. Extent of Works

The specialist Contractor shall supply, install and commission the following warning and Alarm systems comprising a combination of (select) flashing/steady lights and audible alarms, for the appropriate services.

2.9.2. Master and Slave indicating Units

A Master indicating Units shall be installed in nurse stations to monitor all the services in one combined unit.

The Master Unit shall relay to slave Units installed in the following rooms in all other nurse station as will be shown in the drawings.

2.9.3. Electrical Power

The systems shall work on low voltage D.C. current stepped down from a 250 volt single phase supply via a double earth screened transformer. The power pack may be incorporated in the Master Unit.

2.9.4. *(76) Essential Features of Flashing Light Units

The Master Unit and Slave Units shall be of similar construction and embody the following features:-

1. On the Master Unit, solid state flasher unit to operate the lamps through the system.
2. On Master and slave Units, translucent coloured panels for each service engraved with the "fault" conditions.
3. Two under-run low voltage white lamps in parallel behind each panel.
4. A green panel to indicate that the unit is operational.
5. A Standardized size and type of lamp throughout the system.
6. Lamps suitable for rapid on/off flashing operation with long life.
7. Lamp test button on each unit to test all lamps on the unit simultaneously.
8. Audible alarms as indicated in Schedule No. 4
9. On the Master Unit, A Key operated muting switch:-
 - a) Make flashing lights steady on Master Unit and Slave Units
 - b) Mute Audible alarms on Master Unit only.
10. One each Slave Unit, a key operated muting switch to mute audible alarms.
11. The muting switches to deal with only one alarm signal at a time and to re-set automatically.
12. On the Master Unit a System Alarm Circuit run from a dry battery to indicate: -
 - a) Failure of flasher unit.
 - b) Failure to low voltage supply.

These faults to be indicated by a coloured orange engraved panel with steady twin lights and audible alarm with key operated muting switch and automatic =re-set.

A test button shall be provided to simulate "a" and "b" to test the above circuit.

2.9.5. *(76) Essential Features of Steady Light Units

The Master Unit and Slave Units shall be of similar construction and embody the following features: -

1. Translucent coloured panels for each service engraved with the “fault” condition.
2. A translucent green panel to each service to indicate that low voltage supply is on and services are operating normally.
3. Two under-run low voltage while lamps in parallel being each panel.
4. A standardized size and type off lamp thought the system.
5. Lamp suitable for long life.
6. A lamp test bottom on each unit to test all lamps on the unit simultaneously.
7. Audible alarms as indicated in Schedule No.5
8. On the Master Unit, key Operated muting switch to mute audible alarms on the Master Unit only.
9. On each Slave Unit, a Key operated muting switch to mute audible alarms on the Unit.
10. The muting switches to deal with only one alarm signal at a time and to re-set automatically.
11. On the Master Unit, a System Alarm Circuit run from a dry battery to indicate failed of low voltage supply.

This fault to be indicated by a coloured orange engraved panel with steady twin lights and an audible alarm with key operated muting switch and automatic re-set.

A test button shall be provided to simulate low voltage supply failure to test the above circuit.

2.9.6. Working of Master and Slave Units – “Flashing” System

The units shall indicate the condition of all the monitored services simultaneously and for each service more than one panel may be indicating at a time as outlined in Schedule No. 4.

The audible alarm on each unit shall be common to all the services and be arranged to re-set automatically after being muted, or if muting is not carried out, after the fault is rectified.

2.9.7. Working of master and Slave Units – “Steady” System

The units shall indicate the conditions of all the monitored services simultaneously and for each service only one panel will be indicating at a time as outlined in Schedule No.5.

The audible alarm on each unit shall be common to all the services and be arranged to re-set automatically after being muted, or if muting is not carried out, after the fault is rectified.

2.9.8. Arrangement of Panels on Units

The order in which the services shall be arranged on the Master and Slave Units shall be that adopted for terminal unit: -

When facing the panels the service shall be in the following order reading left to right: -
OXY. NIT.OXIDE. NIT OXIDE. CABRBON DIOXIDE COMPRESSED
AIR VACUUM OXY.MIXTURE

2.9.9. Engraving of Fascia Panels of Units

The fascia panels of the Units shall be engraved with the name of the service, either at the top or bottom of each column of translucent panels.

The function of the various press buttons and switches shall also be engraved on the fascia panels.

All engraving shall be picked out in contrasting indelible colour.

2.9.10. Monitoring Equipment

The Specialist Contractor shall include for supply and fixing all necessary sensing Devices, Operating switches and Relays on the plant for the initiation of the Warning and Alarms signals. The Sensing devices, etc. on the Liquid Oxygen Plant and Standby manifold shall be supplied and installed by the Specialist Oxygen Supplier.

Absolute reliability and long life of contracts in relay units shall be as essential feature of the equipment.

The relays shall be energized under normal operating conditions and the alarm contracts shall “break” under “fault” conditions.

The alarm terminal block shall be remote from the electrically isolated from all other terminals and energized from a separate source.

The monitored unit alarm contracts shall be rated at 250 volts 3Amp, 50 Hz and the alarm system contacts at 50 volts, 0.5 Amp, D.C.

On a “Flashing” system the alarm circuit conductors to the slave units shall be suitable so that when the green, white and orange panels on every slave unit are illuminated simultaneously the pressure loss does not exceed 5% of the rated operating voltage.

On a “Steady” System the alarm circuit conductors to the slave units shall be suitable so that when any signal is illuminated simultaneously on all slaves the pressure loss does not exceed 5% of the rated operating voltage.

(Delete the system not required)

2.9.11. Setting of Sensing Devices

The sensing devices shall be set so that the conditions are indicated as soon as the following limits are reached: -

Conditions on Schedule

*(81) Manual manifolds

1. When duty bank falls to approximately: -
 - (a) 10% of full capacity on oxygen systems
 - (b) 8% of full capacity on N₂ O₂ systems
 - (c) 6% of full capacity on N₂O systems

Automatic Manifold

2. When duty bank becomes “exhausted” and change-over to reserve bank made.
3. When with one bank empty, duty bank falls to approximately: -
 - (a) 10% of full capacity on oxygen systems
 - (b) 8% of full capacity on N2 O/O 2 systems
 - (c) 6% of full capacity on N2O systems

Liquid Oxygen Installations

4. When change-over to standby manifold made.
5. When one standby bank becomes exhausted and changeover to reserve bank made.

Medical Compressed Air Plant

6. When “standby compressor cuts in to back up “duty” compressor.
7. When change-over to standby air manifold made (denoting fault on compressors or air temperature too high).
8. When dew point of air from dryers is rising above 0°C (32°F) at 7.3 bar (105 p.s.i.) gauge.

Medical Vacuum Plant

9. When “standby” vacuum pump cuts in to back up “duty” vacuum pump.

All PMG &V Plant Installations

10. When either one or both pumps fail to operate
11. When pressure in distribution pipe work falls to:-
 - a) 10% below normal on medical gas lines
 - b) 15% below normal on air and vacuum lines

2.9.12. Electrical Wiring

The interconnecting wiring shall be carried out by others, but the specialist Contractor shall supply all necessary wiring diagrams, induplicate, within.....weeks of being awarded the contract.

PART C:

PARTICULAR SPECIFICATION FOR MEDICAL GASES

3. PART C: PARTICULAR SPECIFICATION FOR MEDICAL GASES

3.1. MEDICAL GASES

3.1.1. Oxygen Production System – flow rate 65 Nm³/h (1083 l/min) – MEDICAL GRADE

The oxygen production system allows to produce oxygen mainly by means of air compressors and an oxygen producer and shall conform to NHS Health Technical Memorandum HTM02-01. The system is mainly formed by: n°2 air compressors air cooled with a single stage rotary compressor driven by an electrical motor with high efficiency TEFC (IP 55), skid, hood soundproof, injection oil screw rotating elements, air valve air filter for intake, oil filter, oil and water cooling coil water cooled, water separator with electronic discharge for elimination of condensate, air-oil separator, control panel board; n°3 oil separators; n° 3 air dryers with refrigerant R404a (CFC free) with condensate separator, hermetic type of compressor for refrigerant gas equipped with pressure switch to prevent ice formations on the suction side equipped with an electrical heater, cooling circuit equipped with pressure switch against high pressure, expansion valve and receiver tank, air coolant condenser, electric fan motor IP54, heat exchangers made of aluminium, control panel on board; n°3 air filter 1 in backup; n°1 oxygen producer based on Pressure Swing Adsorption equipped with inlet pressure regulator, n°2 tanks with zeolites to contain the nitrogen molecules, pneumatic inlet and outlet valves (one pair for each tower), silencer on the exhaust to reduce the noise level during depressurization and regeneration phases, safety valves, microprocessor control panel; n°1 compressed air reservoir; n°1 compressed oxygen reservoir.

3.1.2. Oxygen Producer

Oxygen generator OGP65 CE 115/230V medical grade including air and oxygen reservoirs

3.1.3. Medical Vacuum Plant – flow rate 1280 l/min each pump

The Medical Vacuum Plant shall conform to NHS Health Technical Memorandum HTM02-01. The Medical Vacuum Plant 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. The system will be mainly equipped with: n°3 vacuum pumps 1280 l/min each, 5.5 kWe each, air-cooled, oil lubricated rotary, each pump shall be equipped with vane type with wire mesh filter and integral non-return valve at the inlet, integral separator filter, duplex bacteria filter system, anti-vibration pads between the pump foot and mounting frame, control board; n° 3 air receivers 1500 l each.

The entire system shall be 'triplex' such that any single functional component failure will not affect the integrity of the medical vacuum supply. The system is the first, second and emergency source.

3.1.4. Combined Medical/Surgical Air Plant (4/7 Bar) – flow rate 4260 l/min each pump

The Medical Air Plant shall conform to NHS Health Technical Memorandum HTM02-01; medical quality air to the European Pharmacopoeia monograph shall be delivered at pressures of 400 kPa (4 bar), 700kPa (7 bar). Compressors shall be oil injected rotary screw with a multistage oil separator, Variable Speed Drive type, high efficiency water separators, oil filters, heatless regenerative desiccant dryer, dust/activated carbon filters, hopcolite

filters and bacterial filters. The system will supply both the medical air and the surgical air for operating theatres and common area. A Quadruplex compressors system will be adopted and it shall supply the specified volumetric flow with three pumps operating and one pump not running; each compressor has a flow rate of 4260 l/min, with 2 receivers with a volume of 2000 l each.

3.1.5. Anaesthetic Gas Scavenging System Duplex Type - flow rate 1560 l/min each pump

The Anaesthetic Gas Scavenging (AGS) System shall comply with HTM 02-01. The AGS system shall be a dedicated, specifically designed active extraction and disposal system for waste anaesthetic gas.

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 simplex or duplex pumps, motor control unit with starter/isolator, moisture drain flask and flexible connectors to connect the plant to the pipeline. Each pump shall include an electric motor and directly coupled impeller assembly. Impeller bearings in the pumps shall not require lubrication. The pumps shall be air cooled and rated for continuous operation. In the present installation only duplex systems will be installed with 1560 l/min each pump.

3.2. OXYGEN MANIFOLD

Main oxygen cylinder banks manifold control system, in compliance with technical specification, diagrams and British standards (Cylinders not included in the price). The system shall be formed by 2X6 cylinder manifold J size 8500 lt/each with a total flow rate 55.23 mc/h. The manifold system shall be equipped with an automatic change over panel which allows the switch between the exhaust oxygen cylinders and the spare cylinders. (BMS Compatible)

3.3. NITROUS OXIDE MANIFOLD

Nitrous Oxide cylinder banks manifold in compliance with technical specification, diagrams and British standards. The system shall be formed by 2X3 cylinder J size 8500 lt/each with an autonomy of 4 hours. (BMS Compatible)

Ditto but 2x2no. Emergency cylinder Manifold.

3.4. NITROGEN MANIFOLD

Nitrogen cylinder banks manifold in compliance with technical specification, diagrams and British standards. The system shall be formed by 2X3 cylinder J size 8500 lt/each with an autonomy of 4 hours. (BMS Compatible)

3.5. SURGICAL AIR 7 BAR MANIFOLD

Emergency surgical air 7 bar cylinder banks manifold in compliance with technical specification, diagrams and British standards. The system shall be formed by 2X6no cylinder J size 8500 lt/each with an autonomy of 2 hours.(BMS Compatible)

3.6. MEDICAL AIR 4 BAR MANIFOLD

Emergency Medical air 4 bar cylinder banks manifold in compliance with technical specification, diagrams and British standards. The system shall be formed by 1X5no cylinder J size 47 lt/each with an autonomy of 4 hours. (BMS Compatible)

3.7. PLANT ALARMS

Supply and installation of a plant alarm to supervise all the medical gas plant. This plant alarm panel shall display gas pressure, normal and alarm conditions of all gases; panel shall contain audible and visual alarm indicators. Each gas service shall consist of a bank of five dual-circuit LED indicators, one green (for "normal" indication), three yellow and one red (for four output conditions).

3.8. A.V.S.U. MULTIPLE BOX - UP TO 7 MEDICAL GAS VALVES

The Area Service Module will contain a medical gas area alarm panel capable of monitoring up to 7 medical gas services by means of pressure sensors, which detect deviations from the normal operating limits, and up to 7 medical gas Area Valve Service Unit. The Area Service Module shall be pre-piped. Medical gas/vacuum services shall be fixed copper, piped to and from their respective area valve service units, and shall normally terminate in 22mm copper stub pipes with an option for 28mm for oxygen and vacuum services. Pipes shall normally be connected at ceiling level and shall be handed as specified by the customer. Area valve service units shall conform to BS EN 739:1998, HTM 02-01 and BS EN 7369.

3.9. A.V.S.U. MULTIPLE BOX - UP TO 5 MEDICAL GAS VALVES

The Area Service Module will contain a medical gas area alarm panel capable of monitoring up to 5 medical gas services by means of pressure sensors, which detect deviations from the normal operating limits, and up to 5 medical gas Area Valve Service Unit. The Area Service Module shall be pre-piped. Medical gas/vacuum services shall be fixed copper, piped to and from their respective area valve service units, and shall normally terminate in 22mm copper stub pipes with an option for 28mm for oxygen and vacuum services. Pipes shall normally be connected at ceiling level and shall be handed as specified by the customer. Area valve service units shall conform to BS EN 739:1998, HTM 02-01 and BS EN 7369.

3.10. A.V.S.U. MULTIPLE BOX - UP TO 4 MEDICAL GAS VALVES

The Area Service Module will contain a medical gas area alarm panel capable of monitoring up to 4 medical gas services by means of pressure sensors, which detect deviations from the normal operating limits, and up to 4 medical gas Area Valve Service Unit. The Area Service Module shall be pre-piped. Medical gas/vacuum services shall be fixed copper, piped to and from their respective area valve service units, and shall normally terminate in 22mm copper stub pipes with an option for 28mm for oxygen and vacuum services. Pipes shall normally be connected at ceiling level and shall be handed as specified by the customer. Area valve service units shall conform to BS EN 739:1998, HTM 02-01 and BS EN 7369.

3.11. A.V.S.U. MULTIPLE BOX - UP TO 3 MEDICAL GAS VALVES

The Area Service Module will contain a medical gas area alarm panel capable of monitoring up to 3 medical gas services by means of pressure sensors, which detect deviations from the normal operating limits, and up to 3 medical gas Area Valve Service Unit. The Area Service Module shall be pre-piped. Medical gas/vacuum services shall be fixed copper, piped to and from their respective area valve service units, and shall normally terminate in 22mm copper stub pipes with an option for 28mm for oxygen and vacuum services. Pipes shall normally be connected at ceiling level and shall be handed as specified by the customer. Area valve service units shall conform to BS EN 739:1998, HTM 02-01 and BS EN 7369.

3.12. MEDICAL BED HEAD,PENDANT AND TERMINAL UNITS

Supply, Install, Test and Commission the following materials, equipment, apparatus, fittings etc. including erection, testing and commissioning as described below and shown on the drawings-

Medical Horizontal Trunking System with 3No. Medical gases terminals, (1No. Oxygen, 1 No. Vacuum and medical air terminals), nurse call system, 2No. Raw power twin sockets, 2No. Clean power twin non-standard socket, equipotential earth socket, telephone point, Examination Lights, Up and Down lights provisions complete with lamp, 2No. data points and a top rail for other fixings as Beacon Medaes or equal and approved. (Electrical to sockets to be universal standards).

Medical Ceiling Fixed Pendant System with 6No. Medical gases terminals, (1No. Oxygen, 1 No. Vacuum, 1No. Medical air, 1No Nitriuos Oxide, 1No. Surgical air and 1No. Nitrogen, nurse call system, 8No. Clean power twin non-standard socket, equipotential earth socket, telephone point, 2No. twin data points and a top rail for other fixing as Beacon Medaes or equal and approved.(Electrical to sockets to be universal standards).

Medical Ceiling Double Arm Pendant System with 4No. Medical gases terminals, (1No. Oxygen, 1 No. Vacuum, 1No. Medical air, and 1No. Pure Oxygen, nurse call system, 8No. Clean power twin non-standard socket, equipotential earth socket, telephone point, 2No. Twin data points and a top rail for other fixing as Beacon Medaes or equal and approved. (Electrical to sockets to be universal standards).

3.12.1. Terminal Units

Medical gas terminal units shall be as Medaes Gem 10 or approved equivalent and shall conform to BS 5682: 1984 and International Standard 9170.

Terminal units shall be gas specific and accept only the correct medical gas probe.

Gas specific components shall be pin-indexed to ensure that a correct gas specific assembly is achieved such that in the normal course of dismantling for repair or maintenance, parts from other gases cannot inadvertently be used.

Terminal units shall be designed to allow easy and accurate installation and shall be supplied with installation instructions and a comprehensive Operating and Maintenance Manual.

Terminal units shall be capable of single handed insertion and removal of the correct BS 5682: 1984 medical gas probe and shall have a minimum 3 year warranty. All terminal unit installations can be achieved the use of Double Arm Pendants, Ceiling fixed Pendants, Bedhead Units, Wall Terminal units etc. depending on the application.

3.12.2. Isolating Valves

Medical gas line ball valves shall be as Medaes Limited or approved equal and shall be constructed of a nickel plated brass body, PTFE seats/seals and a brass chrome plated ball. The valve shall operate by a manual operating lever selected through 90°. All medical gas line ball valves shall provide a full bore flow and shall be cleaned for oxygen service and

fully tested prior to dispatch. Smaller Type V valve assemblies (15 to 42mm inclusive) shall incorporate stainless steel “Dowty” bonded seals and mechanically sealed connectors. Larger Type VF valve assemblies (54 to 108mm inclusive) shall be flanged, installed with stainless steel bolts, nuts and spring washers, with 3mm Viton sealing gaskets. In all cases, the use of PTFE tape or any other thread sealing medium shall not be used during installation.

Each medical gas line ball valve assembly shall terminate in copper stub pipes to enable brazing direct into the distribution system, using the fluxless brazing technique. A lockable device shall be provided and enable the valve to be locked in either the fully open or fully closed position.

Medical gas ball valve assemblies shall comply with, and fully satisfy, the pressure drop requirements of the United Kingdom Health Technical Memorandum No. 2022 and Model Specification C11.

3.1 DISTRIBUTION PIPEWORK

3.1.1 Introduction

Distribution pipework shall be manufactured, installed and commissioned in accordance with the United Kingdom Health Technical Memorandum No. 02-01 (where specified), and the National Health Service – Model Engineering Specification C11.

3.1.2 Pipework Materials

Pipework materials are manufactured by a licensee of the BS 5750 quality assurance certification scheme and all pipes and fittings are marked with the BSI kitemark.

3.1.3 Component Cleanliness and Protection

Component cleanliness and protection procedures are carried out on all pipes, fittings, components and equipment for use with all Medical gas services. Final residual contamination level does not exceed 100mg/m² when tested by the method specified in ASTM B280 Clause 12. All equipment and items supplied to site are fully protected against the ingress of dirt and contamination by:

- (a) Sealing small components in polythene bags or boxes.
- (b) Individual end capping of pipes.
- (c) Bundling and sleeving pipework in polythene bags.
- (d) Wrapping or boxing

3.1.4 Cleaning and Degreasing

Copper pipes are cleaned and degreased by oxygen service in accordance with BOC Specification 399394. Fittings are cleaned, flux removed, dried and degreased for oxygen service in accordance with BOC Specification 399856. All packaging is labeled “Degreased for Medical gas service”.

3.1.5 Pipework Supports

3.1.6 Spacing

Distribution system pipework is normally supported at intervals specified in table below:

Metric sizes outside diameter Mm	Maximum internals for vertical runs Metres	Maximum intervals for horizontal runs Metres
6	1.0	1.0
12	1.2	1.0
15	1.8	1.2
22	2.4	1.8
28	2.4	1.8
35	3.0	2.4
42	3.0	2.4
54	3.0	2.7
76	3.6	3.0

3.1.7 Secondary Fixing Brackets

Except for vertical drops to terminal units, secondary fixing brackets comprise a suitable metallic, non-ferrous material or a ferrous material suitably treated to prevent corrosion and electrolyte action. For vertical drops to terminal units, secondary fixing brackets comprise a suitable metallic, non-ferrous material or a non-metallic material.

3.1.8 Brazed Pipework Jointing

Copper to copper joints made on-site, utilize a copper phosphorous brazing alloy type CP1 or CP4 to BS 1845 and an inert gas shield and no flux. Copper or brass or gunmetal joints made off-site, utilize a silver brazing material type AG13 to AG18 to BS 1845, with a flux, and the joint is subsequently cleaned and degreased for oxygen service.

3.1.9 Pipe Preparation

Pipe ends are cut clean and square with the pipe axis using wheel cutters.

Cut ends and the inside of fittings are thoroughly cleaned. Expanded tube joints are formed with the correct pipe expanding tools and are only used for straight tube to tube joints on pipe sizes 28mm and below.

3.1.10 Inert Gas Shielding

Inert gas shielding is provided internally for all on-site fluxless jointing and hot forming of bends. Inert gas is Nitrogen to BS 4105.

PART D
BILLS OF QUANTITIES

4. PART D: BILLS OF QUANTITIES

4.1. GENERAL NOTES TO TENDERERS

The Bills of Quantities form part of the contract documents and are to be read in conjunction with the contract drawings and general specifications of materials and works.

1. The prices quoted shall be deemed to include for all obligations under the sub-contract including but not limited to supply of materials, labour, delivery to site, storage on site, installation, testing, commissioning (**excluding 16% VAT**).
2. All prices omitted from any item, section or part of the Bills of Quantities shall be deemed to have been included to another item, section or part thereof.
3. The brief description of the items given in the Bills of Quantities are for the purpose of establishing a standard to which the sub-contractor shall adhere. Otherwise alternative brands of **equal** and **approved** quality will be accepted.
4. Should the sub-contractor install any material not specified here in before receiving **written approval** from the Project Manager, the sub-contractor shall remove the material in question and, **at his own cost**, install the proper material.
5. The grand total of prices in the price summary page must be carried forward to the **volume 1**.
6. The Bills of Quantities are divided generally into three sections:-

5.1 Contractual Requirement – Bill 1

The sub-contractor shall study the conditions and make provision to cover their cost in this Bill. The number of contractual items to be priced by the Tenderer have been limited to tangible items such as site office, temporary works and others. However the Tenderer is free to include and price any other items he deems necessary taking into consideration conditions he is likely to encounter on site.

5.2 Installation Items – Other Bills

The brief description of the items in these Bills of Quantities should in no way modify or supersede the detailed descriptions in the contract Drawings, conditions of contract in volume 1 and specifications. The unit of measurements and observations are as per those described in the contract documents.

5.3 Summary

The summary contains tabulation of the separate parts of the Bills of Quantities carried forward with provisional sum, and any prime cost sums included. The sub-contractor shall insert his totals and enter his grand total tender sum in the space provided below the summary.

This grand total tender sum shall be carried forward to main summary of volume 1 of the main works.

4.2. BILLS OF QUANTITIES

SECTION D.W. 1: MEDICAL GASES SERVICES

Item	Description	Unit	Qty	Rate	KShs.
<p>1.1</p> <p>A</p>	<p><u>MEDICAL PLANTS:</u></p> <p><u>Supply, Install, Test and Commission the following materials, equipment, apparatus, fittings etc. including erection, testing and commissioning as described below and shown on the drawings-</u></p> <p><u>COMBINED MEDICAL/SURGICAL AIR PLANT</u></p> <p>The Medical Air Plant shall conform to NHS Health Technical Memorandum HTM02-01; medical quality air to the European Pharmacopoeia monograph shall be delivered at pressures of 400 kPa (4 bar), 700kPa (7 bar). Compressors shall be oil injected rotary screw with a multistage oil separator, Variable Speed Drive type, high efficiency water separators, oil filters, heatless regenerative desiccant dryer, dust/ activated carbon filters, hopcolite filters and bacterial filters. The system will supply both the medical air and the surgical air for operating theatres and common area. A Quadruplex compressors system will be adopted and it shall supply the specified volumetric flow with three pumps operating and one pump not running; each compressor has a flow rate of 4260 l/min, with 2 receivers with a volume of 2000 l each. The plant to be as Beacon Medaes cAIR-4260-QGF7 or approved equal with automatic change over station, Pressure reducing stations, BMS Compatible and all items to complete the installation to approval</p>	<p>No.</p>	<p>0</p>		
<p>Total Carried to next page</p>					

Item	Description	Unit	Qty	Rate	KSHs
1.2	<p>Total from previous page</p> <p><u>MEDICAL VACCUM PLANT</u> The Medical Vacuum Plant shall conform to NHS Health Technical Memorandum HTM02-01. The Medical Vacuum Plant 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. The system will be mainly equipped with: n°3 vacuum pumps 1280 l/min each, 5.5 kWe each, air-cooled, oil lubricated rotary, each pump shall be equipped with vane type with wire mesh filter and integral non-return valve at the inlet, integral separator filter, duplex bacteria filter system, anti-vibration pads between the pump foot and mounting frame, control board; 3no. Air receivers 1500 l each. The entire system shall be 'triplex' such that any single functional component failure will not affect the integrity of the medical vacuum supply. The system is the first, second and emergency source. Model as Beacon Medaes mVAC1280T or approved equal and BMS Compatible. Allow for all necessary items to complete the installations to approval.</p>	No.	0		
1.3	<p><u>MEDICAL PORTABLE VACUUM PLANT</u> supply the following Mobile and independent Vacuum as SAM 14 Portable Vacuum Plant:-Cap- 0 to 0.85bar;Flow rate-30litres/Min; Collection Jars-2x2Litres;Unit Dimensions- 380x650x200mm(HxWxD);Weight-11kg;Voltage- 230+/-10%-50/60Hz,110v+/-5%- 50/60Hz;Compliance with medical directive 93/42/EEC,BS EN ISO 10079-1,BS EN 60601-1,BS EN 60601-2 or equal and approved</p>	No.	0		
Sub-Total Carried to next page					

SECTION D.W. 1: MEDICAL GASES SERVICES

Item	Description	Unit	Qty	Rate	KShs.
	Sub-Total from previous page				
1.4 A	<p><u>MEDICAL OXYGEN PLANT</u> The oxygen production system allows to produce oxygen mainly by means of air compressors and an oxygen producer and shall conform to NHS Health Technical Memorandum HTM02-01. The system is mainly formed by: 2no. air compressors water cooled with a single stage rotary compressor driven by an electrical motor with high efficiency TEFC (IP 55), skid, hood soundproof, injection oil screw rotating elements, air valve air filter for intake, oil filter, oil and water cooling coil water cooled, water separator with electronic discharge for elimination of condensate, air-oil separator, control panel board; 3no.oil separators; 3no. air dryers with refrigerant R404a (CFC free) with condensate separator, hermetic type of compressor for refrigerant gas equipped with pressure switch to prevent ice formations on the suction side equipped with an electrical heater, cooling circuit equipped with pressure switch against high pressure, expansion valve and receiver tank, air coolant condenser, electric fan motor IP54, heat exchangers made of aluminium, control panel on board; 3no. Air filter 1 in backup; 1no. Oxygen producer based on Pressure Swing Adsorption equipped with inlet pressure regulator, 2no. tanks with zeolites to contain the nitrogen molecules, pneumatic inlet and outlet valves (one pair for each tower), silencer on the exhaust to reduce the noise level during depressurization and regeneration phases, safety valves, microprocessor control panel; 1no. Compressed air reservoir; 1no.compressed oxygen reservoir. The Unit to be as Atlas Copco PSA-OPG65, Size 1000x2000x3400(WxHxD) and 3500Kg or approved equal with all items to complete the installation and BMS Compatibility to approval.</p>	No.			
	Sub-Total Carried to sub-collection				

Item	Description	Unit	Qty	Rate	KSHs
1.5 B C	<p><u>MANIFOLD SYSTEMS</u> All the below manifolds to be complete with an automatic change-over panel - complete with pressure-valves, pressure-regulators, electromechanical valves, non-return and isolation valves, pressure gauges, test-points as GEM 10, audio and visual alarms and indicators, and all other accessories for proper functioning. The manifolds should allow for automatic switching between the exhausted cylinder bank and spare cylinders bank, and indicate change-over, full and empty conditions. All manifolds to be BMS-integratable. Allow for cylinders, and cylinder-filling in pricing. All manifolds to be in line with HTM 02-01.</p> <p><u>OXYGEN MANIFOLD</u> Main oxygen cylinder banks manifold control system, in compliance with technical specification, diagrams and British standards. The system shall be formed by 2 X 6 cylinder manifold, cylinder size 8500 L each, J-size, with a total flow rate 55.23 mc/h. Manifold, and all components, including ambient-heated vaporizers/pressure-reducers, to be capable of constant, high-flow rate application (above 300L/min flow) without freezing, or ice-up. Change-over panel and manifold to be as Beacon Medaes or an approved equivalent.</p> <p>Ditto but 2x4 Emergency cylinder Manifold, with automatic sensing and opening (engagement).</p>	No.	1		
1.6 D	<p><u>NITROUS OXIDE MANIFOLD</u> Nitrous Oxide cylinder banks manifold in compliance with technical specification, diagrams and British standards. The system shall be formed by 2X3 cylinder manifold, cylinder size 8500 L each, J-size, with an autonomy of 4 hours. Change-over manifold to be as Beacon Medaes or an approved equivalent.</p>	No.	1		
Sub-Total Carried to next page					

Item	Description	Unit	Qty	Rate	KSHs
	Sub-Total from previous page				
E	Ditto but 2x2no. Emergency cylinder Manifold, with automatic sensing and opening (engagement).	No.	1		
1.7	<u>SURGICAL AIR 7 BAR MANIFOLD</u>				
F	Emergency surgical air 7 bar cylinder-banks manifold in compliance with technical specification, diagrams and British standards.The system shall be formed by 2X3 cylinder manifold, cylinder-size 8500L each, J-size.	No.	1		
1.8	<u>MEDICAL AIR 4 BAR MANIFOLD</u>				
G	Emergency Medical air, 4 bar, cylinder banks manifold in compliance with technical specification, diagrams and British standards.The system shall be formed by 2X6 cylinder manifold, cylinder-size 8500L each, J-size.	No.	1		
Sub-Total Carried to next page					

SECTION D.W. 1: MEDICAL GASES SERVICES

Item	Description	Unit	Qty	Rate	KShs.
	Sub-Total from previous page				
1.9 A	<u>NITROGEN MANIFOLD</u> Nitrogen cylinder banks manifold in compliance with technical specification, diagrams and British standards. The system shall be formed by 2X3 cylinder manifold, cylinder-size 8500L each, J-size.	No.	1		
2 B	<u>PURE OXYGEN MANIFOLD</u> Pure Oxygen cylinder banks manifold in compliance with technical specification, diagrams and British standards. The system shall be formed by 2X2 cylinder manifold, cylinder-size 8500L, J-size.	No.	1		
2.1 C	<u>ANAESTHETIC GAS SCAVENGING SYSTEM</u> The Anaesthetic Gas Scavenging (AGS) System shall comply with HTM 02-01. The AGS system shall be a dedicated, specifically designed active extraction and disposal system for waste anaesthetic gas. 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 simplex or duplex pumps, motor control unit with starter/isolator, moisture drain flask and flexible connectors to connect the plant to the pipeline. Each pump shall include an electric motor and directly coupled impeller assembly. Impeller bearings in the pumps shall not require lubrication. The pumps shall be air cooled and rated for continuous operation. In the present installation only duplex systems will be installed with 1560 l/min each pump. The system to be AGS -1560-D/3X5(4op.+1 commune) from Beacon Medaes, and BMS Compatible.	No.	3		
Sub-Total Carried to sub-collection page					

SECTION D.W. 1: MEDICAL GASES SERVICES

Item	Description	Unit	Qty	Rate	KShs.
2.3	<u>ZONE SERVICES UNITS</u>				
A	Zone service unit for 1 No. gas in valve boxes 20mm dia. as Beacon Medaes ZSU or an approved equivalent. Tenderers to allow for different ZSU gases, e.g. Oxygen, Vacuum, Medical Air, Surgical Air, AGSS, Nitrous Oxide, Nitrogen, Pure Oxygen.	No.	60		
2.4	<u>MEDICAL GAS AREA ALARM SYSTEM</u>				
B	Medical Gas Area Alarm, complete with pressure switches, LCD panel, high and low-flow/pressure alarms, visual and audio alarms and indicators, and all other accessories necessary for proper functioning. Alarm to be for 2 No. gases and to be as Beacon Medaes Medipoint 26 or an approved equivalent.	No.	4		
C	Ditto but for 3 No. gases.	No.	3		
D	Ditto but for 6 No. gases.	No.	4		
E	Ditto but for 1 No. gas.	No.	1		
	<u>TERMINAL UNITS</u>				
F	Medical gas wall terminal units as Beacon Medaes GEM 10 or equal and approved for Oxygen	No.	160		
G	Medical gas wall terminal units as Beacon Medaes GEM 10 or equal and approved for Vacuum	No.	160		
H	Medical gas wall terminal units as Beacon Medaes GEM 10 or equal and approved for Medical Air	No.	40		
I	Medical gas wall terminal units as Beacon Medaes GEM 10 or equal and approved for Nitrous Oxide	No.	10		
J	Medical gas wall terminal units as Beacon Medaes GEM 10 or equal and approved for Pure Oxygen	No.	5		
K	Medical gas wall terminal units as Beacon Medaes GEM 10 or equal and approved for Nitrogen	No.	5		
K	Medical gas wall terminal units as Beacon Medaes GEM 10 or equal and approved for Surgical Air	No.	10		
L	Medical AGSS Remote Switch module complete wiring and item for proper functionality of the module to approval.	No.	5		
Sub-Total Carried to sub-collection					

Item	Description	Unit	Qty	Rate	KShs.
	Sub-Total from previous page				
C	Medical Horizontal Trunking System with 8No. Medical gases terminals, (2No. Oxygen, 2 No. Vacuum, 2 No. medical air, 1 No. Nitrous Oxide, 1 No. AGSS terminals), nurse call system (knock-out size to nurse-call supplier spec.), 8 No. single, unswitched power sockets wired into 2 No. separate circuits, colour blue. Equipotential termination, dual network points, Examination Lights, Up and Down light provisions complete with lamp and switches, and a separate room light switch (complete with termination, to be wired by others), and a top rail for other fixings as Beacon Medaes or equal and approved. - Theatre Prep	No.	6		
D	Series 9a ceiling column vertical pendant System with 9No. Medical gases terminals, (2No. Oxygen, 2 No. Vacuum, 2 No. medical air, 1 No. AGSS, 1 No. Nitrous Oxide, 1 No. Surgical Air terminals), nurse call system, 5 No. Raw power twin sockets, 5 No. Clean power twin non-standard socket, equipotential earth socket, telephone point, 2No. data points and a top rail for other fixings as Beacon Medaes or equal and approved.	No.	4		
E	Predisposition for Medical Ceiling Double Arm Pendant System, including steel plates, fixing elements, screws, bolts, fittings and any other accessory to allow for future installation of equipment.	No.	26		
Sub-Total Carried to sub-collection page					

SECTION D.W.1: MEDICAL GASES SUB-COLLECTION

Item	Description	Unit	Qty	Rate	KShs.
	<u>MEDICAL GASES SERVICES</u> <u>SUB-COLLECTION PAGE</u>				
A	Medical Plants				
B	Manifolds & AGSS				
C	Plant Alarms				
D	ZSU's, Area Alarms & Terminal Units				
E	Medical Bedhead, Pendants				
Sub-Total carried to Main collection page					

SECTION D.W.3 MEDICAL GASES PIPE WORK

Item	Description	Unit	Qty	Rate	KShs.
3.1	<p><u>MEDICAL GASES PIPEWORK</u></p> <p>The distribution pipe work shall be manufactured, installed, tested and commissioned in accordance with NHS Health Technical Memorandum HTM02-01 and the Nation Health Service – Model Engineering Specification C11. Pipework materials shall be manufactured by a licensee of the BS 5760 quality assurance certification scheme and all pipes and fittings are marked with the BSI Kitemark. Pipes to be phosphorous de-oxidised non-arsenical copper to BS 6017 and BS 2871 and marked to BS 2871. Tenderers to allow for brazing, reducers supports, flux, clippings, cleaning, bending, forming and degreasing as necessary for the proper functioning of the installations as specified: Clippings to be 4m apart.</p> <p>A. 76mm dia. copper pipe.</p> <p>B. 54mm dia. copper pipe.</p> <p>C 42mm dia. ditto.</p> <p>D 35mm dia. ditto.</p> <p>E 28mm dia. ditto.</p> <p>F 22mm dia. ditto.</p> <p>G 15mm dia. ditto.</p> <p><u>Fittings to BS 6017 Grade C106 of sizes and manufacture to BS 864 Part 2.</u></p> <p>H 76mm dia. copper bend.</p> <p>I 54mm dia. copper bend.</p> <p>J 42mm dia. ditto.</p> <p>K 335mm dia. ditto.</p> <p>L 28mm dia. ditto.</p> <p>M 22mm dia. ditto.</p> <p>N 15mm dia. ditto.</p> <p>O 15mm dia. tee.</p> <p>P 22x15x15mm dia ditto</p> <p>Q 22mm dia. ditto.</p> <p>R 28x22x22mm dia ditto</p> <p>S 32mm dia. ditto.</p>				
Sub-total carried to next page					

Item	Description	Unit	Qty	Rate	KShs.
	Sub-Total from previous page				
T	32x28x28mm dia ditto	No.	10		
U	42mm dia. ditto.	No.	150		
V	42x32x28mm dia ditto	No.	80		
W	54mm dia. ditto.	No.	60		
X	54x42x32mm dia ditto	No.	40		
Y	76mm dia. ditto.	No.	50		
Z	76x76x54mm dia ditto	No.	30		
Sub-Total carried to sub-collection					

SECTION D.W.3 MEDICAL GASES PIPE WORK

Item	Description	Unit	Qty	Rate	KShs.
3.1	<p><u>MEDICAL GASES PIPEWORK - cont.</u> The distribution pipe work shall be manufactured, installed, tested and commissioned in accordance with NHS Health Technical Memorandum HTM02-01 and the Nation Health Service – Model Engineering Specification C11. Pipework materials shall be manufactured by a licensee of the BS 5760 quality assurance certification scheme and all pipes and fittings are marked with the BSI Kitemark. Pipes to be phosphorous de-oxidised non-arsenical copper to BS 6017 and BS 2871 and marked to BS 2871. Tenderers to allow for brazing, reducers supports, flux, clippings, cleaning, bending, forming and degreasing as necessary for the proper functioning of the installations as specified: <u>Fittings to BS 6017 Grade C106 of sizes and manufacture to BS 864 Part 2.</u></p>				
A.	22mm dia. Medical gas line ball valve assemblies	No.	60		
B.	15mm dia. ditto.	No.	40		
C	42mm dia. ditto.	No.	25		
D	32mm dia. ditto.	No.	16		
E	28mm dia. ditto.	No.	16		
F	54mm dia. ditto.	No.	16		
G	76mm dia. ditto.	No.	10		
H	22mm dia. Medical gas line Air release valve assemblies	No.	8		
I	15mm dia. ditto.	No.	8		
J	42mm dia. ditto.	No.	4		
K	32mm dia. ditto.	No.	4		
L	28mm dia. ditto.	No.	4		
M	54mm dia. ditto.	No.	2		
N	76mm dia. ditto.	No.	2		
O	22mm dia. Medical gas line none return valve assemblies	No.	18		
P	15mm dia. ditto.	No.	22		
Q	42mm dia. ditto.	No.	8		
Sub-Total carried to next page					

Item	Description	Unit	Qty	Rate	KShs.
	Sub-Total from previous page				
R	32mm dia. ditto.	No.	8		
S	28mm dia. ditto.	No.	6		
T	54mm dia. ditto.	No.	2		
U	76mm dia. ditto.	No.	2		
Sub-Carried to sub-collection					

SECTION D.W. 3: MEDICAL GASES SUB-COLLECTION PAGE

Item	Description	Unit	Qty	Rate	KShs.
	<p><u>SUB-COLLECTION PAGE</u></p>				
A	Medical Gas Pipework				
B	Medical Gas Pipework - cont.				
Sub-Total Carried to Main Collection Page					

MEDICAL GASES COLLECTION PAGE

Item	Description	Unit	Qty	Rate	KShs.
	<u>MAIN COLLECTION PAGE</u>				
D.W.1	Medical Plants, Manifolds and Units				
D.W.2	Medical Gases Pipe Work				
D.W.3	Flow Meters	No.	10		
D.W.4	Probes	No.	24		
D.W.5	Allow for 2 No. additional fills/cylinder-replacements for all gas cylinder manifolds.	Item			
D.W.6	Painting and marking of medical gas pipe work in line with HTM 02-01.	Item			
D.W.7	Purging, cleaning, and filling all medical gas piping.	Item			
D.W.8	Training of users (client)	Item			
D.W.9	Testing and commissioning	Item			
D.W.10	As installed drawings	Item			
Total Carried Forward to Main Summary of Volume I					

5. PART E: TECHNICAL SCHEDULE

5.1. Documentation Requirements

Document	With Bid	Before Manufacture	During FAT	Upon Delivery
Preliminary general arrangement drawing (with dimensions)	YES			
QA / QC Plan in accordance with ISO 9001:2008		YES		
General arrangement drawing (with dimensions)		YES		
Schematics/Line diagrams for construction	N/A	YES	N/A	N/A
Recommended Spares List	N/A	N/A	N/A	YES
Routine Test Reports / Certificates			YES	
Type Test Reports / Certificates	N/A	N/A	YES	N/A
Commissioning Procedure	N/A	N/A	N/A	YES
As-built General arrangement drawing			YES	
As-built Schematics			YES	
Site Test Reports / Certificates				YES
Special Test Reports / Certificates	N/A	N/A	YES	NO

5.2. TECHNICAL SCHEDULE

The tenderer **MUST SUBMIT** comprehensive manufacturer's technical brochures and performance details for all items listed in this schedule (fill forms attached).

ITEM No.	Description	Remarks
A	Copper pipe	
B	Bedhead	
C	Medical Plants	
D	ZSU's	
E	Medical pendant	
F	Terminal units	
G	Manifolds	

6. PART F: DRAWING SCHEDULE:

6.1. DRAWING SCHEDULE

As shall be provided during project implementation.