SUPPLY, INSTALLATION, TESTING AND COMMISSIONING OF MEDICAL GAS PIPELINE AND MANIFOLD SYSTEM

Technical specifications of Centralized Medical Gas Pipeline system and Manifold system for 6 New All India Institute of Medical Sciences

The system comprises of
1. Oxygen manifold with fully automatic control panel and emergency manifold
2. Nitrous oxide manifold with automatic control panel and emergency manifold.
3. Vacuum (suction) supply system complete.
4. Air supply system (4 bar & 7 bar) complete.
5. Distribution piping complete with accessories.
6. Area Valve Service System.
7. Alarm Systems.
8. Pendants and bed head panels
9. Outlets.
10. AGSS system.
11. CO2 Systems (Optional).

RESPONSIBILITY OF BIDDER

The job will be turn-key basis and the bidders are required to visit the sites before submitting their bid.

Bidder shall be responsible for complete design, supply, installation, testing and commissioning including turnkey works, demolition and construction as applicable .The bidders are required to survey the site before furnishing the quotations.

Bidder shall execute all required civil, electrical, plumbing, lighting, fire safety, exhaust systems and other works as maybe required for complete installation and trouble-free functioning as a part of the 'turnkey work'. Hospital will provide electrical supply with isolator in the plant. The wiring, peripheral lighting, fans, exhaust etc have to be done by the bidder. Control panel for Vacuum system and Air plant system has to be supplied by the bidder. Bidder will be responsible for trenching or other associated work related to installation and commissioning of complete MGPS system.

The MGPS bidder has to terminate all the medical gas lines outside the OT. Installation and commissioning of area valve service unit and alarm unit for the operation theatre shall be done by the MGPS bidder. Medical gas pipe line inside the minor operation theatre has to be done by the MGPS bidder. Medical gas pipe line inside the modular operation theatre shall be done by the MOT bidder. MGPS bidder shall cooperate with the MOT bidder for the successful completion of MGPS inside the modular operation theatres.

The bidder shall be responsible for the complete works including the submission of working Drawings, and isometric views, detailed work schedule and materials. Bidder shall be responsible for installation and commissioning of medical gas supply system in coordination with AIIMS authorities. Bidder shall be responsible for free maintenance of Gas pipeline system, other plants and manifolds during warranty period. Bidder shall be responsible for commissioning of Oxygen manifold system, Vacuum plant, Air plant ,AGSS system, Medical Gas lines, Area valve service units, Alarm systems Gas out lets and OT

pendants, CO2 Systems ie MGPS complete. Design, supply, installation, testing and commissioning should be as per HTM/NFPA standards.
Bidder should provide factory test certificates for the materials used. Bidder should supply complete set of part manuals, service manuals and user manuals for all the systems and subsystems to be supplied. Training for a week at AIIMS to the selected staffs and engineers has to be provided by the bidder for a period of one week minimum and at the satisfaction of the staffs. Final electrical safety test, system test, and calibration should be done by authorized persons using calibrated test equipment as per HTM/NFPA standards. Bidder or his authorized agent should post a trained experienced engineer who should be available at site or should reach the site within 8hrs of raising a service call.

1. OXYGEN SUPPLY SYSTEM

1.1 Secondary Oxygen Manifold – 2 x 20 Class-D type bulk cylinders

Manifold shall consist of two high pressure header bar assemblies to facilitate connection of 20nos of primary and 20nos of secondary cylinder supplies. Each header bar shall be provided with 20 numbers of cylinder pigtail connections to suit cylinder valves as per IS.3224 incorporating a check valve at the header connection. The high-pressure header bar shall be designed in such a manner that it can be extended to facilitate additional cylinder connections. Each header bar assembly shall be provided with a high pressure shut off valve.

Oxygen Manifold should consist of 2 X 20 nos of D-type oxygen cylinders. The manifold should be hydraulically tested to 3500 psig. The manifold should be so designed that it shall suit easy cylinder changing and positioning. The system should have non – return valves for easy changing of cylinders without closing the bank. The cylinder should be placed with the help of cylinder brackets and fixing chains which should be galvanized.

It shall confirm to HTM 02-01/NFPA 99C.

1.2 Fully Automatic Oxygen Control Panel:

The fully automatic oxygen control panel should comply with HTM 02-01/NFPA 99C .It should be European CE Certified or UL listed under Medical Devices Directive.

The manifold assembly should provide two stages of pressure regulation. A single stage primary regulator, one for each cylinder bank should be used to initially reduce cylinder pressure and two single stage pressure regulators should be provided in the control cabinet for final delivery pressure regulation. One delivery pressure regulator in service and one should be ready for service in a standby mode. The Manifold control panel should be digital, fully automatic type and switches from "Bank in Use" to "Reserve bank " without fluctuation in delivery supply line pressure. Changeover should be performed by electrically/pneumatically operated valves contained in the control cabinet. In the event of an electrical power failure the valves should automatically open to provide an uninterrupted gas flow. It should be 100% automatic and should not require manual adjustment.
The automatic gas manifold control should include:

- supply pressure gauges x 2Nos
- delivery pressure gauge x 1No
- Line pressure regulators with bypass valve x 2Nos

- line pressure relief valve x 1No
- green in service LED indicators, one for each supply bank x 2Nos
- amber / yellow ready for service LED indicators, one for each supply valve x 2Nos
- red LEDs to indicate depleted cylinders, one for each supply bank x 2Nos
- Instruction for changing the cylinders should be clearly identified on the front of the control panel.
- All functional components should be enclosed in corrosion resistant robust material.
- Delivery flow capacity should not be less than 2000 litres per min. at 60psig.

The control panel should be as per HTM 02-01, NFPA 99 C.

All components inside the Control Panel like Pressure Regulators, piping and control switching equipment should be cleaned for Oxygen Service and installed inside the cabinet to minimize tampering with the regulators or switch settings.

The Control Panel shall include two pressure relief valves, one high pressure approx.200psi and one low pressure approx.75 psi.

The heavy duty control panel should be provided with a flow capacity of over 2000 LPM.

1.3 Emergency Oxygen Manifold – 2 x 10 Class-D type bulk cylinders

Manifold shall consist of two high pressure header bar assemblies to facilitate connection of 10nos of primary and 10nos of secondary cylinder supplies. Each header bar shall be provided with 10 numbers of cylinder pigtail connections to suit cylinder valves as per IS.3224 incorporating a check valve at the header connection. The high-pressure header bar shall be designed in such a manner that it can be extended to facilitate additional cylinder connections. Each header bar assembly shall be provided with a high pressure shut off valve.

Oxygen Manifold should consist of 2 X 10 nos of D-type oxygen cylinders. The manifold should be hydraulically tested to 3500 psig. The manifold should be so designed that it shall suit easy cylinder changing and positioning. The system should have non – return valves for easy changing of cylinders without closing the bank. The cylinder should be placed with the help of cylinder brackets and fixing chains which should be galvanized.

It shall confirm to HTM 02-01/NFPA 99C.

1.4 Oxygen Flow meter with Humidifier Bottle

Back Pressure Compensated flow meter for accurate gas flow measurement with following features:

A) Control within a range of 0-15 LPM.
B) It should meet strict precision and durability standard.
C) The flow meter body should be made of brass chrome plated materials.
D) The flow tube and shroud components should be made of clear, impact resistant polycarbonate.

E) Flow tube should have large and expanded 0-15 LPM range for improved readability at low flows.
F) Inlet filter of stainless steel wire mesh to prevent entry of foreign particles
G) The humidifier bottle is made of unbreakable & reusable polycarbonate material autoclavable at 121 degree centigrade (15 mins).

1.5 High pressure tube for O2, N2O, Compressed Air, Nitrogen, CO2, & Vacuum

It should be imported colour coded for individual services i.e. white for Oxygen, Blue for N2O and Yellow for Vacuum, Black for air. Antistatic rubber tube should be as per ISO standards.

2 NITROUS OXIDE SYSTEM

2.1 Nitrous Oxide Manifold -2 X10 Class-D type bulk cylinders

Manifold shall consist of two high-pressure header bar assemblies to facilitate connection of primary and secondary cylinder supplies. Each header bar shall be provided with 10 number of cylinder pigtail connections to suit cylinder valves as per IS3224 incorporating a check valve at the header connection. The high-pressure header bar shall be designed in such a manner that it can be extended to facilitate additional cylinder connections. Each header bar assembly shall be provided with a high pressure shut off valve. The manifold should be so designed that it shall suit easy cylinder changing and positioning. The cylinder should be locked with the help of cylinder brackets and fixing chains which should be galvanized. It shall confirm to HTM 02-01/NFPA 99C.

2.2 Fully Automatic Nitrous Oxide Control Panel

The fully automatic N2O control panel should comply with HTM 02-01/NFPA 99C .It should be European CE Certified or UL listed under Medical Devices Directive.

The manifold assembly should provide two stages of pressure regulation. A single stage primary regulator, one for each cylinder bank should be used to initially reduce cylinder pressure and two single stage pressure regulators should be provided in the control cabinet for final delivery pressure regulation. One delivery pressure regulator in service and one should be ready for service in a Standby mode. The Manifold control panel should be digital, fully automatic type and switches from “Bank in Use” to “Reserve bank “ without fluctuation in delivery supply line pressure. Changeover should be performed by electrically/pneumatically operated valves contained in the control cabinet. In the event of an electrical power failure the valves should automatically open to provide an uninterrupted gas flow. The manifold should not require any manual resetting or adjustments after the replacements of the depleted cylinders.

The automatic gas manifold control should include:

- supply pressure gauges x 2Nos
- delivery pressure gauge x 1No
- Line pressure regulators with bypass valve x 2 Nos
- line pressure relief valve x 1No
- green in service LED indicators, one for each supply bank x 2Nos
- amber / yellow ready for service LED indicators, one for each supply blank x 2Nos

- red LEDs to indicate depleted cylinders, one for each supply bank x 2Nos
- Instruction for changing the cylinders should be clearly shown on a metal plate attached on the front of the removable cover of the control panel.
- All functional components should be enclosed on fire resistant, robust synthetic polymer/SS.
- Delivery flow capacity should not be less than 1000 liters per min. at 60psig.

The Control Panel shall include two pressure relief valves, one high pressure approx.200psi and one low pressure approx.75 psi.
The control panel should also have heaters to prevent ice formation on the regulators at high flow rates.
The Control Panel should be made to provide Heavy Duty and have a flow capacity of 1000 LPM.

2.3 Emergency N2O Manifold – 2 x 4 Class-D type bulk Cylinders

Manifold shall consist of two high-pressure header bar assemblies to facilitate connection of primary and secondary cylinder supplies. Each header bar shall be provided with 4 numbers of cylinder pigtail connections to suit cylinder valves as per IS 3224 incorporating a check valve at the header connection. The high-pressure header bar shall be designed in such a manner that it can be extended to facilitate additional cylinder connections. Each header bar assembly shall be provided with a high pressure shut off valve. Nitrous oxide manifold should consist of 2 rows of 4 cylinders. It shall confirm to HTM 02-01/NFPA 99C.

The manifold should be hydraulically tested to 3500 psig. The manifold should be so designed that it shall suit easy cylinder changing and positioning. The system should have non – return valves for easy changing of cylinders without closing the bank. The cylinder should be placed with the help of cylinder brackets and fixing chains which should be galvanized.

3 CARBON DIOXIDE SYSTEM

Medical CO2 Manifold 2 x 4 Nos of Class-D type Cylinders

The Modular Manifold supply system shall provide carbon dioxide piped distribution system. It shall confirm to HTM 02-01/NFPA 99C.

The Modular Manifold system should be in such a way that it increases flexibility and allows easy enlargement of the manifold capacity in case of future expansion. The system should comprise basic components and shall be constructed of i.e. Primary Header, Secondary Header, cylinder racks, non-return valve, blanking plug, and corner connector.

The primary head should be mounted on an 8 cylinder rack which can be connected to the left and right inlets of automatic Control Panel. Each header should have a brass block with 2 non – return valves and brazed connection pipe. Corner connector should be available to enable installation of manifold headers around corners of the room. The manifold supply system cylinder rack should locate vertical gas cylinders which should be restrained by chains. It should be made from steel for durability and with powder coated paint finish.

Heater should be added to prevent freezing in the line and the line should be insulated properly.

Each Non-return valve shall have a hard seat ceramic ball. Soft seat Non-return valves are not acceptable. The non – return valves should be incorporated into the header assembly to protect the system in the event of tailpipe fracture. For better access and increased safety, the non-return valve block should be positioned on the header rack mid – way between the cylinder positions. Flexible copper tail pipes should be used to connect the gas cylinders and the manifold header connection points.

The CO2 manifold should be installed in a suitable location in OT complex.
A custom length corner connector shall also be available to enable header manifolds to be installed in a "U" configuration across 3 adjacent walls of the room. Manifold shall have specific tailpipe connections in accordance with HTM 02-01/NFPA 99C

3.1 Fully Automatic Control panel for CO2 System

The Manifold Control System should supply any type of medical gas from both left and right hand manifold banks. Operation and performance criteria should fully satisfy the requirements of HTM 02-01/NFPA 99C. The fully automatic CO2 control panel should comply with HTM 02-01/NFPA 99C .It should be European CE Certified or UL listed under Medical Devices Directive.

The Manifold Control System shall supply on uninterrupted flow of **1000 L/min**. to a 400 k Pa (4 bar) distribution system. Either the left or right hand manifold bank may be designated "Duty" and should automatically changeover to supply the distribution system from the "Standby" bank when pressure in the "Duty" bank falls to a predetermined level.

There should be a 2 stage duplex system of pressure regulation to provide a high flow rate. Each side should be capable of being fully isolated, via a full flow ball valve, in order to change any regulator without a cessation of supply. The inlet of the 1st stage regulator should be protected from the particulate matter by a moulded bronze filter.

All regulators should be protected from over-pressurization by relief valves which are vented to atmosphere. There should be a bypass valve fitted to the 2nd stage regulators to allow CO2 to be vented outside the manifold room during the commissioning stage. Regulators shall comply with BS EN ISO 10524-2 and shall have documented test reports available confirming successful completion of the oxygen ignition tests stated therein. Multi stage regulators combined into single unit is not acceptable.

To simplify installation there should be an installation bracket attached to the wall with four screws; the main panel then should locate on to this bracket and be secured. The Control Panel should be housed in a single panel having a solid construction using epoxy technology in a glass reinforced polymer moulding for high strength, high chemical and corrosion resistance. The cover should hinge upwards but should remain facing outward for manual operation and maintenance accessibility. For added safety the voltage inside the panel should not exceed 12v dc. The mains supply transformer should be in its own housing in a moulded recess at the rear of the panel.

There should be a fail-safe system in the event of power failure so that solenoid valves open and there is full continuity of supply pressure and flow. Upon power restoration the unit should revert back to the original bank of cylinders being used. To avoid inadvertent resetting of the "change cylinder alarm" the solenoid valves should be latched so that once

changeover has occurred and the cylinders have been replaced, a reset button must be operated to cancel the alarm condition.

To aid maintenance, the connections within the panel should be flat face/'O' ring design and facilitate easy removal of the regulators and pressure switches. There should be manual changeover buttons so that servicing either side of the system can be simply achieved. The PCB's should be linked with plug and socket connectors for easy removal. The manifold control systems should be 'CE' marked under the Medical Devices Directive (Lloyd's Register Quality Assurance).

4. VACUUM SYSTEMS

4.1 Oil Sealed Rotary Vane Medical Vacuum System

Rotary Vane Medical Vacuum System should comply with HTM 02-01/NFPA 99C .It should be European CE Certified or UL listed under Medical Devices Directive.

It should be fully HTM 02-01/NFPA 99C compliant for use in medical vacuum and dual Medical / Surgical applications. The unit will consist of electric motor driven pumps vacuum receiver, electrical control system and interconnection piping and wiring. The components shall be modularly assembled for easy service.

4.1.1 Vacuum Pump Module

- It should fully comply and meets with the requirements of the HTM 02-01/NFPA 99C
- Designed flow capacity should be minimum 7000 LPM ± 10% variation in pentaplex configuration.
- It should be CE marked/UL listed. The medical vacuum plant shall be manufactured under an ISO 13485:2003 quality management system.
- The medical vacuum plant shall **comprise pentaplex, air-cooled, oil lubricated rotary vane vacuum pumps** to provide a flow rate of at least **7000 l/min ± 10**% with two pumps in standby to maintain a vacuum level of 450 mmHg at the plant connection point.
- The vacuum plant shall comprise five air-cooled, oil lubricated rotary vane vacuum pumps suitable for both continuous and frequent start/stop operation at inlet vacuum levels between 500mmHg and 660 mmHg.
- The control system should normally employ automatic rotation of the lead pump to maximize pump life and ensure even wear.
- Vacuum pump inlets shall include a wire mesh filter and integral non-return valve to prevent oil suck back and pressure increases in the vacuum system.
- Each vacuum pump shall be fitted with anti-vibration pads between the pump foot and mounting frame. The plant shall be fitted with duplex bacteria filter system. Each individual filter shall have the capacity to deliver full design flow such that one set is designated duty and the other will be standby. Bacteria filters shall have efficiency at least 99.999% when tested by the sodium flame method in accordance with BS 3928:1969 utilising particles in the 0.02 to 2 micron size range. The pressure drop across each clean filter at 50% of the system design flow should not exceed 25

mm Hg (3 kPa) at a vacuum of 475mm of mmHg (63 kPa). Bacteria filters shall be marked with the legend 'Bio-Hazard'.

- Each bacteria filter shall be provided with a transparent sterilizable collection jar to collect condensate. The total water capacity of the pressure vessels shall be at least 100% of the design flow rate of the plant in 1 minute in terms of free air aspired. The plant control and power management system shall monitor the safe operation of the plant, providing signalling into the alarm system as per the requirements of HTM 02-01/NFPA 99C. Vacuum pump exhaust shall be piped out of the plant room and discharged outside the building at high level away from windows and any other air intakes.

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4.1.2 Vacuum Receiver

The vacuum receiver shall be constructed to ASME standards, made of steel and fabricated as per IS:2825 for a vacuum pressure of 760mmHg.It should include bypass valves, manual drain valves, vacuum gauge. Vacuum reservoir shall have total volume of at least 100 % of plant output in one minute in terms of free air aspired at normal working pressure.

4.1.3 System Controls

The control include individual self-protected combination motor controls with short circuit, single phase and thermal overload protection, individual control circuit transformers with fuse less primary and secondary protection, pressure sensors, temperature switches with reset buttons, and an electronic controller to automatically change the operating sequence of the compressors. The system should have a status display to show the system pressure, elapsed time, maintenance interval, fault conditions, and silence button, lighted Hand-Off-Automatic selector switches and safety disconnect operating handles.

All required local alarm functions should be integrated into the packaged system. The circuitry should be designed so that the audible signal can be silenced and the visual indicator will remain until the fault has been cleared and the reset button resets. Local alarm functions should be annunciated for reserve pump in use.

4.1.4 Accessories

Accessories included for job site installation are inlet and discharge flexible connectors, vibration mounting pads, and source isolation valve, inlet check valve, oil temperature gauge, thermal malfunction switch and vacuum control switch. Flexible connectors on inlet and exhaust of each pump, exhaust tee with union as well as copper tubing with Shut-off-cock for gauge and vacuum switch etc.

4.1.5 Bacterial Filters

The filters should be designed for removal of solid, liquid and bacterial contamination from the suction side of vacuum pump systems, preventing damage to the pump and the potential biological infection of the surrounding environment. The dryer should be particulate filter dryer with ability to remove particles as small as 1micron.

4.2 Ward Vacuum Units

- It must consists of the following:- 1no of Suction Regulator and 1no of 1000 ml polysulfone collection jar.
- Suction Regulator: Suction regulator should be supplied with a safety jar, including and antibacterial filter and an anti-overflow safety device. Should have wide membrane continuous suction controller
- Should have vacuum levels: 0-760 mm of Hg
- Should have vacuum gauge fitted with a protective bumper device.
- Should have on/off knob allowing for the quick restoration of a readjusted vacuum level.
- Must have central adjustment knob with a color coded for 0 to 760 mm of Hg. Should have Polysulfone 1000cc safety jar, autoclavable at 134^{o} C at 5mins, unbreakable, fitted with an anti-overflow safety device and equipped with a plastic antibacterial filter. It should be totally transparent, to ensure perfect sucked liquid visibility.

4.3 Theatre Vacuum unit

- It must consist of the following: - 1no. Suction Regulator and 2nos. 4000ml polysulfone collection jar and both to be mounted on a trolley.
- Suction Regulator: Suction regulator should be supplied with a safety jar, including an anti-bacterial filter and an anti-overflow safety device. Should have wide membrane continuous suction controller
- Should have vacuum levels : 0-760 mm of Hg
- Should have vacuum gauge fitted with a protective bumper device.
- Should have on/off knob allowing for the quick restoration of a readjusted vacuum level.
- Must have central adjustment knob with a color coded for 0-760 mm of Hg. Should have polysulfone safety jar, autoclavable at 134^{o} C, unbreakable, fitted with an anti-overflow safety device and equipped with a plastic antibacterial filter.
- Collection jar should be totally transparent, to ensure perfect sucked liquid visibility.

5. MEDICAL AND SURGICAL AIR SYSTEM

Should have the following main features

- Air-cooled compressors for continuous duty application
- Highest output of compressed air per HP i.e. low power consumption
- Very low vibration resulting in low noise level

5.1 Air Compressor

- **Pentaplex Rotary screw/scroll** Continuous Compressed Air System with Desiccant Dryers**.**

5.1.1 Compressor Modules

There should be **Pentaplex Medical Air Plant of 7000 lpm (Package unit**). The medical air plant shall fully comply with the requirements of the (HTM 02-01) or NFPA-99C.

The medical air plant should comply with HTM 02-01/NFPA 99C .It should be European CE Certified or UL listed under Medical Devices Directive.

A copy of the certificate should be submitted along with technical bid. The medical air plant shall be manufactured under an ISO13485:2003 quality management system. A copy of the certificate of registration shall be provided for review.

Medical quality air shall be delivered at a nominal pressure of 400 kPa(4 bar) or 700 kPa(7 bar) gauge for supply of the hospital medical air system. The medical air plant shall deliver both medical and surgical air, with a minimum total flow rate of 7000 l/min.

Compressor plant should be designed in such a way that compressors will switch on in a sequential manner as per flow demand.

Three Identical air compressors should run to provide a flow rate of 7000lpm and two identical air compressors will be standby. The compressors should be standalone ones with independent power supply

Each rotary screw/scroll compressors should be suitable for both continuous and frequent start/stop operation at a nominal outlet pressure of 1000 kPa gauge (10 bar) shall be provided. The duty compressors shall be automatically rotated by the plant control system to ensure even wear. Compressors shall be supplied with a block and fin style after cooler with a dedicated quiet running fan to maximize cooling and efficiency. Each compressor shall be fitted with a multistage air/oil separator, capable of limiting oil carry over to a maximum of 3 ppm to minimize contamination and maintenance. Each desiccant dryer shall be provided with a dew point sensing switch that shall provide an alarm on the plant control panel and central hospital alarm system when the water concentration in the delivered air rises above the limit. Duplex desiccant dryer and filtration modules shall be provided with three individual stages of filtration as follows:

Stage 1: Coalescing filter upstream of the desiccant dryer for removing liquid water, oil and oil aerosol down to 0.1mg/cu.m (0.1 ppm) and particles down to 1micron.
Stage 2: Particulate filter after the desiccant dryer for dust protection and removing particles down to 1 micron.
Stage 3: Bacteria filter for removing particles down to 0.01 micron.

Purity should be tested as per HTM 02-01/NFPA 99C standards.

Total air receiver capacity shall be at least 50% of the plant capacity in 1 minute in terms of free air delivered at normal working pressure. Each air receiver shall be protected by a pressure relief valve, a fusible plug and include a pressure gauge with isolating valve and a drain cock. The plant control and power management system shall monitor the safe operation of the plant, providing signal into the alarm system as per the requirements of HTM 02-01/NFPA 99C

Pressure Reducing Station for 4 bar and 7 bar should fully comply and meet with the requirements of the HTM 02-01 or NFPA-99C.Simplex pressure reducing station shall comprise as in-line pressure regulator, with downstream pressure gauge. Isolation valves and pressure release valves should be provided as per HTM 02-01/NFPA 99C

Duplex pressure reducing station to have two branches, connected to the MGPS in parallel in order to allow maintenance on the components of one branch, while the gas flow is maintained in the other branch.

Ball Valves - Full bore which operate from fully open to fully closed position with a quarter turn of the handle.

Complete pressure reducing station with base plate mounted for ease of installation.
Padlocks available to allow locking of the valves in both open and closed positions and must have easy to read pressure gauges. Base plate mounted and supplied with copper stub pipes for ease of installation using inert jointing procedures.

The compressor system should have-

- Intake filter Check Valve Delivery pipe
- Mounting on air tank along with all standard fittings viz. safety valve, pressure gauge, delivery valve, drain valve etc.
- Bidder shall provide all electric control panels, starters etc required for proper functioning of motor.
- Desiccant Air Dryer – 2 nos.
- Twin 3-Stage Breathing Air Filters – 2 sets
- Outlet pressures for drills/equipment and ventilators should be a minimum of 7 bar and 4 bar respectively.

The compressor should be heavy duty, reliable with long MTBF. Each compressor cylinder is to be protected by a temperature switch, which will stop the drive motor and provide an alarm signal in the event of abnormal discharge air temperature. Each compressor module should include an inline filter with particle retention of 10 microns, inlet isolation valve, discharge isolation valve, and pressure relief valve. The capacity should be capable to take care of total load of all the outlets.

5.2 Air Receiver

The corrosion resistant coated receiver is to be equipped with tested safety pressure relief valve, sight glass pressure gauge, automatic drain, three-valve by-pass and source isolation valve. Total air receiver capacity shall be at least 50% of the plant capacity in 1 minute in terms of free air delivered at normal working pressure.

5.3 Air Treatment Module

The air treatment module should include dual dryers, dual filtration system and a dewpoint transmitter with local audible and visual signals and dry contacts for remote monitoring. The components should be mounted on a common base with interconnecting copper/brass piping and upstream and downstream isolation valves. The isolation valves must allow either set of components to be serviced without shutting down the system.

Dryers should be of heatless desiccant design and sized to provide for the peak calculated demand. The desiccant dryers should be equipped with dew point dependent switching feature to minimize the need for purge air.

The dual filtration system should remove liquid and particulate matter, consisting of 0.5micron coalescing filters with differential pressure indicators and automatic drain, airline pressure regulators with gauges, final pressure relief valve, and sampling valve.

Each bank should consist of three stage treatment. Digital dew point monitor is to be supplied with alarm contacts as per requirement of HTM02-01/NFPA 99C.

5.4 System Controls

The electrical control will be of a fuse less design in a NEMA 12 enclosure .The"Continuous on Demand" feature will stop the operation of the motors during periods of low or no demand. The control include individual self-protected combination motor controls with short circuit protection, single phase and thermal overload protection, individual control circuit transformers with fuseless primary and secondary protection, pressure sensors, temperature switches with reset buttons, and an electronic controller to automatically change the operating sequence of the compressors. The cabinet shall have an HMI (Human Machine Interface) system status display to include system pressure, dew point pump operation, accumulated time, maintenance interval, fault conditions, and silence button, lighted Hand-Off-Automatic selector switches and safety disconnect operating handles. All required local alarm functions shall be integrated in to the packaged system.

The system should be designed to function even if the programmable controller fails.

5.5 Accessories

Accessories including for job site installation such as inlet and discharge flexible connectors, vibration mounting pads, and source isolation valve should be supplied.

6. DISTRIBUTION PIPING

6.1 Piping specifications

Solid drawn, seamless, deoxidized, non-arsenical, half hard, tempered and degreased copper pipe conforming to BS EN 13348:2008 standards. All copper pipes should be degreased & delivered capped at both ends. The pipes should be accompanied with manufacturers test certificate for the physical properties & chemical composition.

Copper pipe must have reputed third party inspection certificate (Eg. Lloyd's, TUV, SGS). Fittings should be made of copper and suitable for a working Pressure of up to 17bar and especially made for brazed socket type connections.

The isolation valve body shall be made of chromium plated brass with non lubricated ball-type. All valves shall be pneumatically tested for twice the working pressure and factory degreased for medical gas service.

6.2 Installation & testing

Installation of piping shall be carried out with utmost cleanliness. Only pipes, fittings and valves that have been degreased and fittings brought in polythene sealed bags shall be used at site. Pipe fixing clamps shall be of nonferrous or non-deteriorating plastic suitable for the diameter of the pipe.

All pipe joints should be made using flux less brazing method. All joints should be made of copper-to-copper and brazed by silver brazing filler material without flux. Adequate supports should be provided while laying pipelines to ensure that the pipes do not sag. Suitable sleeves shall be provided wherever pipes cross through walls / slabs. All pipe clamps shall be non-reactive to copper.

After erection, the pipes are to be flushed with dry nitrogen gas and then pressure tested with dry nitrogen at a pressure equal to twice the working pressure or 150 psig, whichever is higher for a period of not less than 24 hours.

6.3 Painting

All exposed pipes should be painted with two coats of synthetic enamel paint and colour codification should be as per British standards.

Oxygen line…..White
Vacuum line….Yellow
Air line……. Black with white band
Nitrous Oxide….Blue

Should have Lloyds certification for pipes and other materials.
The Pipe Sizes to be used are from among as under:

Outside Diameter (mm)	Maximum interval between supports (Horizontal and Vertical)..(m)
12	1.5
15	1.5
22	2.0
28	2.0
35	2.5
42	2.5
54	2.5
76	3.0
108	3.0

7. ALARM SYSTEM

7.1 Master Alarm

Each Master Alarm should be modular in design and be fitted with required number of master alarm modules. The master alarms should be capable to monitor from 10 to 30points in a standard box or 10 to 50 points in a large box.

Each point represents an alarm condition that the source equipment might have. When an alarm condition exists, a red light flashes and the audible alarm sounds. If several alarm conditions occur simultaneously, the most recent alarm light should flash, while the other alarm lights should remain lit. When an alarm condition is created, an audible alarm should

be actuated. A dry contact module should be available to interface with a building management system.

The box material should be of gauge steel of requisite thickness and equipped with mounting brackets that are adjustable up to a drywall thickness of 1-1/4" (32 mm). The emissions from alarms should conform with EMC standards.

Bidder shall be responsible for all cabling from local alarm panels to master alarm panel .

The Equipment should conform to an ISO 13485 facility.
Features

- Complies with HTM 02-01 & NFPA 99C
- High visibility LED/LCD readouts
- Circuitry allows for Normally Open or Normally Closed.
- Adjustable audible alarm repeat (from 1 to 99 minutes)
- Can be interfaced with BMS
- Should be European CE Certified or UL listed under Medical Devices Directive.

7.2 Medical Gas Alarm (Main & Area)

The medical gas central alarms should be capable of monitoring a maximum of 6medical gas services by means of pressure sensors which detect deviations from the normal operating limits of either pressure or medical vacuum. The area alarm should have a digital display of pressures. The medical gas area alarm should fully satisfy the HTM 02-01/NFPA 99C requirements and should be CE Certified or UL listed under Medical Devices Directive.

Each gas service should be displayed by coloured LED's to show 'Normal' (green), 'Low' and 'High Pressure' (red) conditions. Medical vacuum systems should be displayed in the 'Normal' (green) and 'Low Vacuum' (red) conditions only.

Failure indications should be displayed by flashing lights and normal indications should be steady light. An audible warning should sound simultaneously with any failure indication and a mute facility should be provided. Following a mute selection the audible should resound after approximately 15 minutes, or should operate simultaneously should a further alarm condition occur. A maintenance 'Mute' switch should be provided internally to the panel for use during maintenance which results in prolonged pipeline or plant shutdown. This facility should automatically reset when the gas service returns to normal.

The alarm panel should have a 'test' facility to prove the integrity of the internal circuits, LED's and audible warning. The alarm panel should incorporate a volt free normally closed relay to allow for interconnection to either a medical gas central alarm system or an event recording circuit of a building management system.

The alarm should be microprocessor based with individual microprocessor on each module and should provide interface to Gas Delivery Management System. A centralised alarm in the manifold room is also essential.

8. PENDANTS AND BED HEAD PANELS

8.1 Single Arm Moveable Pendant for minor Operation Theatre

The Ceiling Pendants should comply with NFPA 99C/HTM 02-01. The support arms should be extremely robust and revolve on high quality bearings, so that the pendant head glides smoothly and quickly to any desired position. Pendant should be European CE Certified or UL listed under Medical Devices Directive.

The Pendant should be available as follows:

- 1000 mm moveable arm with 340 deg. Horizontal.
- The weight carrying capacity of the arm should not be less than 200 Kgs.
- Should have electromagnetic brakes.
- Arm should be capable of 300-340 degrees of rotation, which can be easily adjusted to suit the desired mode of operation.
- The Pendant Service Heads should have modular head. The head should be capable of accepting a range of shelves, and infusion poles or other accessories.
- The Pendant Head should support the range of Monitor Mounting Solutions.
- The Pendant Service Head should be supplied with medical gas terminal units and 5/15 Amps. Electrical Sockets.
- The medical gas outlets should be provided with pendant as per specification of gas outlets. Each pendant should have:

  Oxygen Outlets– 2,
  Nitrous Oxide Outlet – 2,
  Air (4 bar) Outlets– 2,
  Vacuum Outlets– 2,
  AGSS outlet - 1
  Electrical Sockets - 6 nos. (atleast 3nos of UPS sockets).
  Shelf with two rails one on each side – 1 no.
  Monitor rack

8.2 Horizontal Bed Head Panel.

It shall confirm to HTM 02-01/NFPA 99C. It should have following features

- Efficient, Safe & Robust design in extruded aluminium section.
- Smooth curved surfaces, and choice of base colour and fascia plates.
- Unit should have integrated rail system to mount accessories
- The headwall system should be constructed of aluminium extrusions joined together to form a carcass to suit the particular application. Unit should be factory assembled for electrical and mechanical components.
- Segregation of services i.e. Low voltage supplies, High Voltage supply and Medical gases should be maintained throughout.
- Front fascia plate should be removable individually to access for respective service.
- Bed space management system with optional equipment rail. With all Equipment Rail mount Accessories.
- All down drops should be installed at one end preferably & Vertical drop installed at one end should be covered with Aluminum boxing with matching color.

- Entire pipe line should run in continuous horizontal panels with no break for each unit & length as per area where it has to be installed.
- Each bedhead unit shall be supplied pre-piped, wired and certified.
- Facility per unit as under:

  Oxygen – 2
  Vacuum – 2
  Medical Air-2
  Holder for vacuum collection jar –1
  Nurse call switch – 1
  Gooseneck lamp with flexible LED lighting – 1
  Infusion pump mount pole with adapter for mounting at least two infusion pumps

  5 /15 A combined Electrical outlets – 6.
  RJ-45 socket -01
  Two spare spaces
  Monitor Bracket

9. GAS OUTLETS

9.1 Terminal Units (Gas Outlets) with probes/Adaptors for O2, N2O, Compressed Air (4 &7 bar), AGSS, Vacuum, N2 & CO2 (CO2 & N2 can be optional depending on the requirement)

The outlets should be NFPA99C /HTM 02-01 complaint, cleaned for medical gas service and be pressure tested. Each outlet should have less than 3 psi (21 kPa) pressure drop through the outlet @ 120 l/min.and 50 psig (345 kPa) inlet pressure. For outlets providing positive pressure gas, the outlet should be equipped with a primary and secondary check valve which should be rated for 200 psi (1,379 kPa) allowing the primary check valve to be removed for services without isolating the entire zone.

The wall outlets should have a gas specific back body with steel mounting plate, which allows outlets to be ganged together with a centre line spacing of 5" (127mm). Each back body should be equipped with a 6-1/2" (165mm) length type "K" copper pipe stub which is brazed to the outlet body. The outside diameter of the copper pipe stub should be 1/2" (12.7mm). The inlet pipe can be swivelled 360 degrees for ease of installation. Outlet bodies should be gas specific by means of a gas assembly only with the specific matching gas back body, preventing interchangeability of gas services. The latch-valve assembly, which by means of color coding and wording, should identifythe specific medical gas service provided by the outlet. Outlet should be European CE certified or UL listed.

10. AGSS (Anesthetic Gas Scavenging System) Plant –2500 LPM)

Duplex Anesthetic Gas Scavenging System (AGSS) of 2500 l/min. should be European CE Certified or UL listed under Medical Devices Directive. It shall confirm to HTM 02-01/NFPA 99C. Duplex AGSS System with twin stand alone AGSS pumps of 3phase 2500 l/min capacity each with built in flow indication and pressure regulation valve. It should be mounted on single frame with control panel and separate warning label. One pump working and one stand by and vice versa. The package should consist of two rotary vane vacuum pumps, a control panel, and mounted on a common base frame.

AGSS pump: AGSS pump shall operate completely dry permanently lubricated and sealed. Each pump should be completely air cooled and have absolutely no water requirements.

Control System: The duplex control system should conform to International Standards. The control system should provide automatic changeover from running to reserve with circuit breaker disconnects for each AGSS pump with external operators, full voltage motor starters with overload protection, control circuit transformers, visual and audible reserve unit alarm with isolated contacts for remote alarm. Should be in duplex format and must be chassis mounted ready for installation. Duplex system in-line non-return values should allow individual pump servicing. Active anesthetic gas scavenging systems should be designed to safely remove exhaled anesthetic agents from the operating environment and dispose of them to atmosphere, thus preventing contamination of the operating department and providing a safe and healthy workspace for the personal. AGSS design should be dependent upon flow rate and pressure drop characteristics of the individual components of a systems, it is essential that terminal units, remote controls and pump units. Eight AGSS Remote Control indicators must be provided with the system.

Installation should be on roof top. Piping, Non-Return-Valves (NRVs), and inlet nozzle should be suitably placed.

11. NITROGEN MANIFOLD SYSTEM

11.1 Nitrogen Manifold 2 x 4 Nos of Class-D Cylinders

The Manifold supply system shall provide Nitrogen piped distribution system. It shall confirm to HTM 02-01/NFPA 99C.

The Modular Manifold system should be in such a way that it increases flexibility and allows easy enlargement of the manifold capacity in case of future expansion. The system should comprise basic components and shall be constructed of i.e. Primary Header, Secondary Header, cylinder racks, non-return valve, blanking plug, and corner connector.

The primary head should be mounted on an 8 cylinder rack which can be connected to the left and right inlets of automatic Control Panel. Each header should have a brass block with 2 non – return valves and brazed connection pipe. Corner connector should be available to enable installation of manifold headers around corners of the manifold room. The manifold supply system cylinder rack should locate vertical gas cylinders which should be restrained by chains. It should be made from steel for durability and with powder coated paint finish.

Each Non-return valve shall have a hard seat ceramic ball. Soft seat Non-return valves are not acceptable. The non – return valves should be incorporated into the header assembly to protect the system in the event of tailpipe fracture. For better access and increased safety, the non-return valve block should be positioned on the header rack mid – way between the cylinder positions. Flexible copper tail pipes should be used to connect the gas cylinders and the manifold header connection points.

The N2 manifold should be installed in a suitable location in OT complex.
A custom length corner connector shall also be available to enable header manifolds to be installed in a “U” configuration across 3 adjacent walls of the room. Manifold shall have specific tailpipe connections in accordance with HTM 02-01/NFPA 99C

11.2 Fully Automatic Control panel for N2 System

The Manifold Control System should supply any type of medical gas from both left and right hand manifold banks. Operation and performance criteria should fully satisfy the requirements of HTM 02-01/NFPA 99C. The fully automatic Nitrogen control panel should comply with HTM 02-01/NFPA 99C & CE Certified or UL listed under Medical Devices Directive.

The Manifold Control System shall supply on uninterrupted flow of **1500 L/min**. to a (7 bar) distribution system. Either the left or right hand manifold bank may be designated "Duty" and should automatically changeover to supply the distribution system from the "Standby" bank when pressure in the "Duty" bank falls to a predetermined level.

There should be a 2 stage duplex system of pressure regulation to provide a high flow rate. Each side should be capable of being fully isolated, via a full flow ball valve, in order to change any regulator without a cessation of supply. The inlet of the 1st stage regulator should be protected from the particulate matter by a moulded bronze filter.

All regulators should be protected from over-pressurization by relief valves which are vented to atmosphere. There should be a bypass valve fitted to the 2nd stage regulators to allow Nitrogen to be vented outside the room during the commissioning stage. Regulators shall comply with BS EN ISO 10524-2 and shall have documented test reports available confirming successful completion of the oxygen ignition tests stated therein. Multi stage regulators combined into single unit is not acceptable.

To simplify installation there should be an installation bracket attached to the wall with four screws; the main panel then should locate on to this bracket and be secured. The Control Panel should be housed in a single panel having a solid construction using epoxy technology in a glass reinforced polymer moulding for high strength, high chemical and corrosion resistance. The cover should hinge upwards but should remain facing outward for manual operation and maintenance accessibility. For added safety the voltage inside the panel should not exceed 12v dc. The mains supply transformer should be in its own housing in a moulded recess at the rear of the panel.

There should be a fail-safe system in the event of power failure so that solenoid valves open and there is full continuity of supply pressure and flow. Upon power restoration the unit should revert back to the original bank of cylinders being used. To avoid inadvertent resetting of the “change cylinder alarm” the solenoid valves should be latched so that once changeover has occurred and the cylinders have been replaced, a reset button must be operated to cancel the alarm condition.

To aid maintenance, the connections within the panel should be flat face/'O' ring design and facilitate easy removal of the regulators and pressure switches. There should be manual changeover buttons so that servicing either side of the system can be simply achieved. The PCB's should be linked with plug and socket connectors for easy removal. The manifold control systems should be 'CE' marked under the Medical Devices Directive (Lloyd’s Register Quality Assurance).