Modifications in the Technical Specifications of
Centralized Medical Gas pipelines system and Manifold room

Tentative quantity of gas outlets at JPN Apex trauma center

<table>
<thead>
<tr>
<th>Area</th>
<th>No. of beds</th>
<th>Oxygen outlet</th>
<th>Nitrous oxide outlet</th>
<th>MA-4 outlet</th>
<th>MA-7 outlet</th>
<th>Vacuum inlet</th>
<th>AGSS outlet</th>
<th>OT pendent</th>
<th>Ceiling suspended panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triage</td>
<td>30</td>
<td>60</td>
<td>-</td>
<td>30</td>
<td>-</td>
<td>30</td>
<td>-</td>
<td>-</td>
<td>30</td>
</tr>
<tr>
<td>I.C.U</td>
<td>50</td>
<td>100</td>
<td>-</td>
<td>50</td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>O.T</td>
<td>5</td>
<td>20</td>
<td>20</td>
<td>10</td>
<td>10</td>
<td>20</td>
<td>10</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>Ward</td>
<td>100</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>185</td>
<td>230</td>
<td>20</td>
<td>90</td>
<td>10</td>
<td>200</td>
<td>10</td>
<td>10</td>
<td>80</td>
</tr>
</tbody>
</table>

1. Standard should comply as follows:
   a. Terminal unit shall comply with ISO 9170-1
   b. Gas-specific connector shall comply with the body of a NIST or DISS connector complying with ISO 5359.
   c. Pendants, bed head units, booms shall comply with EN ISO 11197.
   d. Manifold and line pressure regulator shall comply with ISO 10524-2.
   e. Pressure gauges shall comply with the requirement given in ISO 10524-2

2. All equipments, parts, and accessories will be imported except copper piping.
3. Pipe to be certified by the international recognized body eg. LLOYDS/ SGS, IIIrd party inspection.
4. Only one standard system to be adhere of any international standards.
5. Turn key project
The system comprises of

1. Liquid oxygen supply
2. Oxygen manifold with fully automatic oxygen control panel
3. Nitrous oxide manifold
4. Vacuum supply system
5. Ceiling pendant
6. ICU pendant
7. Air compressors
8. Distribution piping
9. Monitoring and alarm system
10. Outlets
11. Accessories

1. **Liquid oxygen supply system**

Liquid oxygen will be primary source of oxygen supply and oxygen manifold shall be secondary and reserve source. It should automatically shift to secondary source in case of fault of primary. The unit will have capacity of 5000 liters with provision for further upgradation. Unit should be of latest version internationally. The unit should be fitted with standard accessories as minimum and should have undergone standard inspection requirement. A certificate to that effect has to be submitted.

2. **Oxygen manifold**

Oxygen manifold of 2 x 6 cylinders (bulk cylinder of D type) having top frame comprising of high pressure copper pipe of size 5/8” ID x 7/8” OD with high pressure brass fitting made of high tensile brass, NRV and high pressure copper tailpiece made of high pressure copper size 3/16” x 3/8” OD. This will be a secondary source of oxygen supply, shall automatically supply the pipeline when primary source of supply become exhausted or fails. Reserve source of supply will be provided by three cylinders manifold system with high flow regulator with gauges and safety valves. Reserve system will be operational in case primary and secondary system fails in emergency. All three sources will remain permanently connected and change over will be automatic. The system shall
have source shut-off valve for easy changing and positioning, without closing the bank. The cylinder should be placed with the help of cylinder brackets and fixing chains which should be zinc plated appropriate. A filter having pore size of no greater than 100µm shall be provided between the cylinder(s) and the first pressure regulator.

3. Nitrous oxide manifold system
Nitrous manifold system shall have 2 x 4 cylinders (bulk cylinder of D type) with source shut-off valve and reserve source of nitrous oxide will be supplied by three-cylinder manifold with source shut-off valve and main shut off valve. Rest will be same as applicable to oxygen manifold system.

4. Vacuum Supply System:

a. Supply system for vacuum shall comprise at least three sources of supply, one reservoir, two parallel bacterial filter and one drainage trap, to suitably ensure flow rate of vacuum as per the international norms at each outlet.

The system should be fully compliant with NFPA latest recommendation.

Three oil sealed rotary vane vacuum pumps; a control panel and a receiver mounted on a common base frame should comprise the package. Out of three, each vacuum pump shall be capable of supplying the system design flow to ensure continuity of supply.

Each pump shall be oil lubricated, dynamically balanced multi-vane design with heavy-duty aluminum alloy vanes. The vane housing shall be a double walled construction. The oil lubrication system shall be a pressure differential design with full re-circulation and multi-stage exhaust oil separation rated at minimum 99.99% efficiency.

Water vapor condensation in the cylinder shall be prevented by means of an automatic gas ballast valve. A non-return valve to prevent oil migration upon shutdown. Each pump should have a 5-micron inlet filter.

Each reservoir shall be fitted with shut-off valve(s), a drain valve, and a vacuum gauge.
Exhaust from vacuum pump shall be piped outside and shall be provided with the means of to prevent insect, debris & water. Exhaust shall be located remote from any air intake, doors, window and other opening in the building.

The exhaust shall be provided with a drain at its lowest point. Means shall be provided to prevent transmission vibrations to the pipeline.

All sources of electrical supply should be connected to the emergency supply. The control system should provide automatic lead / lag sequencing with circuit breaker disconnects for each vacuum pump visual and audible reserve unit alarm, with isolated contacts for remote alarm, manual-off-auto lighted selector switches and runtime hour.

A programmable logic controller should control the automatic alteration of the vacuum pumps with provisions for simultaneous operation if required and automatic activation of reserve unit if required. The control system shall include an automatic minimum run time adjustment to control run time based on demand.

b. AGSS (anaesthetic gas scavenging system): AGS system shall have two oil less rotary compressor and other associated accessories to provide service to all the operation theatre.

c. Electrical Control Panel (For Compressor & Vacuum Pump):
The complete system should work on duplex sequencing and cascading system. The panel should be floor mounted enclosed type. Panel must have one common electrical control panel for both vacuum pumps and both air compressors with automatic switch gear system, for motors, two vacuum switches, two Air pressure switches, complete with wiring & cabling, electrical contractors with single phase preventing units, and Main voltmeter, Ampere meters-4, hour meters-4, duplex system, sequencing & cascade system for vacuum pumps and air compressors. The electrical control panel shall be of cubical type made of CRCA sheet of 16 g with epoxy power coating. The panel shall offer the following facilities.
Main incoming switch of required capacity with bus bar system and light indications for incoming for outgoing power supply with voltmeter and ampere meter selector switches. Individual circuits with switch fuse unit, starters, and controls for 2 nos. Air compressors, Controls for 2 nos. Vacuum pumps with duplex, sequencing and cascade systems.

Duplex: For every impulse alternate pump shall start and in case of failure if any pump the next pump shall start automatically. Sequencing: The first & second machines will start in sequence Cascade: All pumps shall be connected to a cascade system. In case one pump is not able to generate the required vacuum the second shall start and assist the already running pump. When demand reduces the system shall come back to the first pump only. This electrical control panel should have expandable type means the hospital load will increase in future which can be add one / two air compressor & vacuum pumps without any alteration.

5. Ceiling Operation Theatre Pendants:
The pendant shall be twin double arm, electrically operated, motorized, vertical and horizontal swivel motion movement. Pendant extension arm length/console arm length shall be 1000 mm with minimum rotation of the pendant 330°. Adjustable friction brakes should be fitted as standard to each bearing assembly. Pendant should have encapsulated central pivot bearing system, Sealed for life and maintenance free. Pendant carrying capacity should be around 200 kg. Pendant should have encapsulated central pivot bearing system, Sealed for life and maintenance free. Pendant must be heavy duty PU coating to suit modern interior design concepts and each pendant should have internally segregated compartments, for mechanical, electrical and specialist medical services. The pendants and assembly should be imported and should complies and meets requirements of international standard.

Each pendant must have monitor keeping shelf & will accommodate the followings:

- Oxygen-2
- Nitrous oxide - 2
- Vacuum-2
- Compressed air- 2+1 (4 bar & 7 bar)
• Pressure gauges for oxygen and nitrous
• AGSS inlet– 2
• 5/16 amps switch socket outlet- 8
• Point for data cable input-1

6. ICU Modular Bed Head Pendant
Should complies and meets requirements of must be international standard. The pendant for each bed shall be double arm, electrically operated, motorized vertical and horizontal swivel motion movement. Pendant extension arm length/console arm length shall be around 800 mm with minimum rotation of the pendant 330°. The Bed head Pendant should be made from high strength lightweight extruded aluminum profiles. The quality of Aluminum extrusions must be consistent. Pendant should have internally isolated compartments, for electrical and gas terminal units. Pendant should have partition between gas terminal units and electrical sockets. Pendant should be in polyurethane paint for good finish and must have different shades blue and gray or green and gray. Pendant must have provision for the electrical and communication devices. Must have provision for 6 nos. gas outlet
  • Oxygen-2,
  • Vacuum-2
  • Medical air- 2 (4 bar)
  • 5/16 amps switch socket outlet- 10
  • Provision for nurse calling system, just to bell call buzzer.
  • Extra low voltage socket
  • Point for data cable input

Following accessories should be provided with each panel.
  a) 1 no. Rod for drip (IV tree) -1
  b) 2 no. Infusion pump pole rod -2.
  d) 1 no. Utility basket.
  e) Pressure gauges
**Ward wall panel:** Ward will have wall mounted panels with the provision of the followings:
Oxygen-2 (4bar), vacuum-2, sliding panel for fixing IV stand.

**7. Supply system with medical air compressor:**
The air compressor will have Air-cooled, oil free, at least three-air compressor source for continuous duty application. Air compressors should be critical maintenance free (CMF) and seizure free technology, which ensures that the compressors can with, stands continuous use under high temperature and posses high resistance to extreme environments.
Type of compressor: oil scroll technology
Capacity: 1500-2000 liters per minute and maximum pressure 121 psig.

**Following should be provided with compressors:**
- Inlet filter
- Check valve delivery pipe
- Two Conditioning systems
- Two compressed air receiver
- One dew point alarm sensor shall be fitted to the pipeline system down stream of all conditioning system.
- One dryer with shut-off valve and automatic drains.
- An adsorber, a catalyst and filter as required removing contaminants.

Supply system of medical grade air with compressor should comply with the following:

- Oxygen $\geq 20.4\%$ and $\leq 21.4\%$ V/V
- Total oil concentration $\leq 0.1\text{mg/m}^3$ measured at ambient pressure
- Carbon monoxide conc. $\leq 5\text{ml/m}^3$
- Carbon dioxide conc. $\leq 500\text{ml/m}^3$
- Water vapour content $\leq 67\text{ml/m}^3$
- Sulfur dioxide $\leq 1\text{ml/m}^3$
- NO+NO$_2$ $\leq 2\text{ml/m}^3$
8. Distribution piping

The scope of work shall cover all distribution, piping and terminal units for oxygen, nitrous oxide, compressed air and vacuum in order to provide standard flow rate and pressure at the proposed outlet point.

The specifications for distribution piping system should be:

**Material (Pipe):** The piped distribution system shall use copper pipes manufactured from phosphorous de-oxidised non-arsenical copper, seamless, halfhard, tempered to comply with ASTM-B 819.00; 2002 standards. Pipes are to be degreased suitable for oxygen use.

The pipe sizes to be used are from among as under:

<table>
<thead>
<tr>
<th>Copper Pipe OD (in mm)</th>
<th>Thickness (in mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>0.9</td>
</tr>
<tr>
<td>15</td>
<td>0.9</td>
</tr>
<tr>
<td>22</td>
<td>0.9</td>
</tr>
<tr>
<td>28</td>
<td>0.9</td>
</tr>
<tr>
<td>42</td>
<td>1.2</td>
</tr>
<tr>
<td>54</td>
<td>1.2</td>
</tr>
<tr>
<td>76.1</td>
<td>1.5</td>
</tr>
<tr>
<td>108</td>
<td>2.0</td>
</tr>
</tbody>
</table>

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

Copper to copper joints shall be made on site using a silver-copper-phosphorous brazing alloy to BS 1845 using an oxygen free nitrogen inert gas shield and no flux. Copper to brass or gunmetal joints shall not be made on site. Except for mechanical joints used for components, all metallic pipeline joints shall be brazed or welded. The method used for brazing or welding shall permit the joint to maintain their mechanical characteristics up
to $600^0$C. Filler metal for brazing shall nominally cadmium free (less than 0.025% mass fraction).

Medical gas pipeline shall be bonded to an earth terminal as near as possible to the point at which the pipeline enters the building.

All pipelines for medical gases shall be routed in such way that they are not exposed to a temperature less than $5^0$ C above the dew point of the gas distribution pressure.

If pipeline placed underground they shall be placed in duct or tunnels. The duct and tunnels shall be provided with adequate drainage to prevent water accumulation.

Pipeline shall be supported at interval to prevent sagging or distortion. The maximum interval between support for metallic and non-metallic pipes should not exceed the value given below:

<table>
<thead>
<tr>
<th>Pipe outside diameter (in mm)</th>
<th>Maximum interval between support (in meter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 15</td>
<td>1.5</td>
</tr>
<tr>
<td>22 to 28</td>
<td>2.0</td>
</tr>
<tr>
<td>35 to 54</td>
<td>2.5</td>
</tr>
<tr>
<td>&gt;54</td>
<td>3.0</td>
</tr>
</tbody>
</table>

**Test:** After erection, all the new pipes cleaned or purged with the help of dry nitrogen gas. And complete existing and new system will be tested with dry nitrogen 1.5 times of working pressure for 24 hrs. System should be tested for integrity, leakage, obstruction flow, particulate contamination, pressure relief valve, monitoring and alarm system.

The pipes should be accompanied with manufacturers test certificate for the physical properties & chemical composition. Further the pipe should be got tested by a reputed third party, like Lloyds Registrar Services/SGS and certificate to this effect should also be provided. Imported copper fitting shall be made of copper and suitable for steam working Pressure of 17 bar and especially made for brazed socket type connections. All
area of pipeline should be isolated by putting shut-off valve at various levels and lockable line valve to match with HTM 2022, EN737.

**Marking and colour coding:** Pipeline shall be marked with the name and/or symbol adjacent to shut-off valves, at the junctions and the changes of direction, before and after walls and partitions, etc. at the intervals of no more than 10 m and adjacent to terminal units. Marking shall include arrows denoting direction of flow and letters used for marking not less than 6mm high. All existing main pipes and proposed exposed pipes should be painted with two coats of synthetic enamel paint & color codification to comply with ISO 5359. All concealed pipes to have gas identification bands / labels at appropriate distance. Similarly all pipes which need embedding in the wall will be tested/painted / labeled and properly insulated in accordance with ISO 5359.

**9. Monitoring and alarm system**

Monitoring system systems will have four types of alarm, operating alarm, emergency operating alarm, emergency clinical alarm and information signals. All parameters should be displayed in digital form.

Signals should be auditory, visual and indicate colour. Auditory signals can be silenced by operator but silencing period should not exceed 15 min. Auditory and visual signal requirements should comply with IEC 60601-1-8

- The alarm system will be of modular construction and digital type, should provide visual indication of normal status and location of indicator panel should allow continuous observation.
- Indicator panel displaying all operating alarm signals shall be installed in at least one location allowing continuous observation. Signal should indicate:
  1. Changeover from primary to secondary cylinder supply.
  2. Any primary, secondary and reserve cylinder below minimum pressure or content.
  3. Malfunctioning of compressors, vacuum pumps.
- Emergency clinical alarm signal shall be installed in the critical area and an additional panel will be installed near the area shut-off valve and shall indicate area monitored.
- Alarm system shall be designed so that an alarm is initiated if there is electrical power failure between the sensor and the indicator.
- Monitor and alarm system shall be connected to the normal and emergency electrical power supply.
- The default set point shall be ±20% variation from normal condition. Set point shall be adjustable on the board. In addition “Push to Test” & ‘Alarm silence” button shall be easily accessible to operator and test the unit.
- Each specific service shall be provided with LED digital readout comprising of 0-250 psig and 0-30 inch Hg for vacuum.

### Alarm categories and signal characteristics.

<table>
<thead>
<tr>
<th>Category</th>
<th>Indicator colour</th>
<th>Visual signal</th>
<th>Auditory signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency clinical alarm</td>
<td>Complying with IEC 60601-1-8</td>
<td>Complying with IEC 60601-1-8</td>
<td>Complying with IEC 60601-1-8</td>
</tr>
<tr>
<td>Emergency operating alarm</td>
<td>RED</td>
<td>Flashing</td>
<td>YES</td>
</tr>
<tr>
<td>operating alarm</td>
<td>YELLOW</td>
<td>Flashing</td>
<td>YES</td>
</tr>
<tr>
<td>Information signal</td>
<td>GREEN</td>
<td>Constant</td>
<td>NO</td>
</tr>
</tbody>
</table>

10. Terminal Outlets

(To be installed on Wall Recessed (Concealed) / Console; on Ceiling Pendant in ICU and operation theatre)

All outlets should be double lock quick connect and gas specific for the services indicated (viz. O2, N20, MA 4, MA 7 ,AGSS & Vacuum) and to accept only compatible quick connect Geometric Index type st.steel adapters. The outlet shall be meet EN 737, BS 6834, HTM 2022, BS 5682:1984 standards. The rough in assembly shall be of modular design and include a gas specific 16 swg steel mounting plate design to permit onsite ganging of multiple outlets, in any order, on 5” center line spacing. A machine brass
outlet block shall be permanently attached to the mounting plate in such a manner so as to permit the 18” long, 3/8” OD inlet copper tube to be swiveled 360 degrees for the attachment to the piping system. Gas service identification shall be affixed to the inlet tube and face of the mounting plate.

A secondary valve shall be installed in the outlet block assembly for pressure testing and to prevent gas flow when the latch valve assembly is removed for service. A 1/2” high metal flange around the outlet block seal opening shall provide a plaster barrier. A temporary, transparent cover shall be provided to keep debris out of the outlet during installation while permitting labels to be viewed for outlet service identity. The rough in assembly shall contain a double seal to prevent gas leakage between the rough and the latch valve after the walls are finished. A single “O” ring seal shall not be acceptable.

The latch valve assembly shall include an “O” ring seal primary valve and be gas specific for the labeled service and accept only corresponding compatible hose and apparatus adaptors. The latch valve assembly shall be indexed to the corresponding rough in assembly to avoid accidental cross fitting and shall telescope upto 3/4” to allow for variation in finished wall thickness from 1/2” to 1-1/4”. A metal trim plate with permanent, color coded marking of service identification shall be included as part of the latch valve assembly.

For each recessed outlets-a die cast, epoxy powder coated cover plate shall be provided to trim each outlet and to fill the space between adjacent outlet. Cover plate design shall allow latch valves individually removed for servicing.

The latch / locking release mechanism should be incorporated on to the gas outlet with geometrical key indexing on specific adapter (probe) and should also have a parking facility so that in the event of release of probe by pressing the spring loaded center ,the probe /flow meter does not fall down.
11. Accessories:

a. Ward Vacuum Unit Wall Mounted Type
Should be ISO 9000 certified and complies HTM-2022, B.S. Standard. Ward Suction Unit must be a full quality assurance system medical device consists of:

- Suction regulator should be supplied with a safety jar, including an anti overflow safety device.

- Should have continuous suction controller with reliability & fine adjustment. Should have plastic body and cover, preventing risk of corrosion.

- Should have vacuum gauge, on/off knob allowing for the quick restoration of a vacuum level.

- Must have central adjustment knob with a color-coded, polycarbonate, autoclavable, unbreakable, fitted with an anti overflow safety device.

- Collection jar should be unbreakable and autoclavable Polycarbonate jars, Jar capacities must be minimum 1500-2000 ml.

b. Operation theatre vacuum unit:

- Unit will be consisting of two reusable 2000 ml shatter resistance bottle, including an anti overflow safety device, each made up of autoclavable polycarbonate jars.

- A vacuum regulator with instant ON\OFF switch and a three way selector switch with an option to operate either-Left-right-both.

- All above items will be mounted on a trolley having free moving castor wheels.

c. Flow meter with humidifier:

Back pressure compensated flow meter will be of accurate gas measurement with following features:

- Flow control with in range of 0-15 l/min.

- Flow tube should have large and expanded 0-5 liters/min ranges for improved reliability.