TECHNICAL SPECIFICATIONS

OF

VACUUM SYSTEM

FOR

LABORATORIES

OF

NEW CDRI CAMPUS PROJECT

AT

LUCKNOW (UP)
1.0 BRIEF SCOPE OF WORK

The scope of work includes design, supply, installation/erection, testing & successful commissioning and handing over to CDRI the complete Vacuum System for Laboratories.

The work shall be executed as per specifications and applicable standards.

These specifications shall be read in conjunction with the General Conditions of Contract, Additional Conditions of Contract and BOQ.

Power supply of 3 phases, 415 Volts, 50 Hz, AC shall be provided at one point by EPI / CDRI for group testing & commissioning of complete Vacuum System after erection is completed. However, the contractor shall make his own arrangements for power required during construction, fabrication, erection & trial run etc.

2.0 TECHNICAL SPECIFICATIONS OF VACUUM SYSTEM

2.1 GENERAL

For the new upcoming facility of CDRI at Sitapur Road, Lucknow, the laboratories are being built and infrastructure being completed. With regards to utility requirement during drying, filtering and evacuating air from apparatus and similar operations vacuum shall be required. To serve the requirement, the vacuum system is designed to suit requirements of laboratories of Chemical, Preclinical and Biological wings. This shall be common facility in each of chemical, preclinical and biological sections i.e. one system in two buildings. Vacuum shall be generated through a specially customized Centralized Vacuum System, located at Ground Floor of Laboratory. This system is specially designed to meet CDRI requirements. The vacuum achieved shall be in the range of 10 – 20 Torr for entire system at the application point. One set of vacuum system consists of 2 vacuum pumps (Auto/manual mode compatible) with one vacuum receiver of 1 cubic meter capacity.

2.2 SYSTEM DESCRIPTION

Vacuum is utilized in drying, filtering and evacuating air from apparatus etc. The vacuum is intended to be provided vide a Centralized Vacuum System comprising of a set of vacuum pumps, interconnecting piping, valves, mandatory instrumentation, automation, a receiver and control system. The vacuum pumps will be oil lubricated complete with electric motor and inlet filter. The receiver vessel shall be in steel construction with 1KL capacity. This tank will be complete with drain connection, duly painted and its levels controlled through vacuum switches. The range of vacuum dial gauge shall be 0-760 Torr. This system configuration shall be designed to peak demand wherein both the pumps shall be running and during normal demand only one pump shall be running. This is achieved with vacuum controller. To spread the operating hours evenly between the two pumps, the running hour meter is implemented. The running hour meter can be utilized to monitor the run time in hours of each pumps. The instrumentation & automation shall consist of power supply indicators, contact switches, push buttons, selector switch to enable operate pumps in auto and manual mode etc.
Vacuum System shall consist of 3 sets Vacuum pumps (One set of vacuum system consists of 2 vacuum pumps (Auto/manual mode compatible) with one vacuum receiver of 1 cubic meter capacity.) having capacity of 300 m³/hr per pump. Each pump drawing air from vacuum inlets or equipment connected to the pump(s) by a piping network.

Vacuum pumps are connected to a receiver of Capacity of 1000 Ltrs (1KL) from which air is withdrawn to produce the vacuum. The piping distribution system is also connected to the receiver.

The receiver provides a reserve capacity to allow the periodic shut-down of the pumps and also serves as a tank to intercept and drain off liquids that accidentally find their way into the piping network.

**Diversity Factor:** The diversity factor established for general laboratories is based on experience. For the design of Laboratory Uses Maximum 50 -60 % usage has been considered for entire system at a time.

User points considered in Laboratory are approximately 200 nos. And each point has capacity of 1.0 CFM. So at time nearly maximum 100- 120 points shall be in operation

**Allowable Friction Loss:** A generally accepted figure used to size a piping system is to allow a total friction loss of 3 in (75 mm) Hg for the entire distribution system after the source assembly piping is taken into consideration.

**Recommended Velocity:** A generally accepted maximum velocity is 5,000 feet per minute (fpm) or 25 meters per second (m/s) ±5%.

### 2.3 SCOPE OF WORK OF CENTRALIZED VACUUM SYSTEM

The Centralized Vacuum System consists of:

1. Vacuum pumps (Oil lubricated with electric motor and inlet filter) with Receiver tank in steel construction with 1 KL capacity duly painted with provision for drain – 3 sets
2. Vacuum switches for controlling of Vacuum levels in the tank – 2Nos.
3. Vacuum dial gauge (0-760 Torr) – 1 No.
5. Electrical control panel with power supply indicators, contact switches, push buttons, etc. – 1 Set
6. Selector switch in order to operate the pumps in automatic mode or manual mode. – 1 No.
7. Inter connecting piping & Valves. – 1 Set
8. Supply of piping materials to work site/shop, fabrication and erection of all piping system in accordance with this specification, enclosed specifications for pipes, valves, painting, etc. applicable drawings and standards and also necessary modifications which shall come during erection.
9. Fabrication and erection of pipe supports, supporting fixtures, brackets. As per pipe support material used MS Chanel/Angle/Plates as per standards IS 808/1730/1731 and drawings and instructions of Engineer-in-Charge.

10. Underground piping including covering materials, excavation and backfilling. Anchor Block/insert lock, supports, and pedestal (concrete) pipe sleepers.

Procedure for underground piping as follows:

10.1 No primer paint is required.

10.2 Three coats of cold coal tar (SHALIMASTIC H. D. or equal) shall be applied resulting in a final film thickness of .79 mm simultaneously in inner wrap of fiber glass reinforced or equal shall be pulled in to it. Manufacturer recommendation shall be followed for the coal tar application.

10.3 Immediately following the application of the inner - wrap a layer of outer – wrap (Fiber glass based impregnated with coat tar or equal) shall be applied to the external surface of the coating.

10.4 The coating shall then be allowed to dry and shall be protection from burrs, scratches and sharp edges.

10.5 This procedure is only applicable for MS & CS pipe. Since we are using SS pipe so that procedure will not applicable.

11. The contractor shall also bear the cost of repair, changes, replacement, etc. due to noncompliance with the standards, codes or due to disregard of instructions given by Engineer-in-Charge.

12. a) Dye - penetration test for 100 % of the total number of joints,
    b) Radiography of 10 % of all Butt Welding Joints is must.

13. Flushing, cleaning and testing of all piping system.

14. Providing Single coats of red oxide zinc chromate primer and oil painting on all structural supports, etc.

Any other items as required in the drawings/specifications to be fabricated and erected from pipe/plate materials.

LOCATION / BUILDINGS WHERE VACUUM SERVICE ARE TO BE PROVIDED:

Vacuum service is to be provided in North & South Wing of Chemical, Preclinical and Biological Labs, as per the table given below:

<table>
<thead>
<tr>
<th>Service</th>
<th>Chemical Labs</th>
<th>Preclinical Labs</th>
<th>Biological Labs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vacuum</td>
<td>Shall be provided in all labs</td>
<td>Shall be provided in all labs</td>
<td>Shall be provided in all labs</td>
</tr>
</tbody>
</table>
2.4 TECHNICAL SPECIFICATIONS OF PUMP, PIPE, PIPE FITTINGS AND VALVES:

1) Vacuum Pump:
   - Make: Toshniwal / Kirloskar/ HindVac/IR
   - Type: Oil lubricated.
   - Gas Service: Vacuum
   - Tank Capacity: 1000 Ltrs (Either Built in or External)
   - Flow Capacity: 300 Nm3/hr
   - Vacuum Level: 10 – 20 Torr
   - Ultimate Pressure: 0.5 mbar (0.375 Torr)
   - Motor Rating: 415V +/-10 %, (3 Phase) 50Hz, IP 55, Insulation class F
   - Motor Power: 6 KW
   - Motor Speed: 1500 min-1
   - Noise Level: 72 dB (A)
   - Oil Capacity: 7 Lit.
   - Water vapour capacity: 3.6 kg/hr
   - Water vapour tolerance: 30mbar

2) Stainless Steel Pipes:
   - Material: Seamless Pipes
   - Material of Construction: SS 304
   - Standard: as per ASTM A 312 TP 304, Seamless.
   - Dimensional Standard: ANSI B 36.19
   - Length: 4-6 Mtrs Length
   - Sizes: 65 NB / 40 NB / 25 NB / 15 NB, Sch 40
   - Make/Supplier: Ratanmani / Remi / Sumitomo / Surya / Sunrise

3) Stainless Steel Pipe Fittings:
   - Material: Pipe Fittings
   - Material of Construction: as per ASTM A 312 TP 304
   - Type: Socket Weld/ Butt Weld
   - Dimensional Standard: ANSI B 16.9 / B 16.11
   - Sizes: 50 NB / 40 NB / 25 NB / 15 NB, Sch 40
   - Make/Supplier: Bharat Forge / Fitwell / Sanghi Impex / Swastik Engg / Navkar / Kinnari / Excell Hydro

4) Isolation Valves for Floor Isolation and Room Isolation:
   - Type: Ball Valve
   - Material Of Construction: SS 304
   - Size: 50NB/40NB/25NB, Screwed or Socket weld type
   - Inlet Connection: As per system / Piping Requirement.
   - Make: GG Valves, AUDCO, AVCON, Legris/ Shenco
5) Vacuum Pressure Gauges:

- Material Of Construction: SS 304/316
- Make: WIKA/Waree/Gauges Bourdon
- Size: 100 mm Dial and 2.0 or 2.5 " Dial size
- Range: 0 to -760 Torr

6) S.S Tubing:

- Material: SS 304 as per ASTM A269 TP 304
- Size: ½ OD, 1mm TO 1.2 mm thick, Seamless, 4-6 Mtrs. straight length.
- Gas Service: Vacuum.

7) Isolation Valves for Point of use:

- Type: Needle Valve for Flow/Vacuum Control
- Material Of Construction: SS 304
- Size: ½"
- Inlet Connection: As per system / Piping Requirement.
- Make: Avcon, Vico Engg, Legris, Festo

8) S.S Tube Fittings:

- Make: Prime Engineers/Excel Hydro, Equivalent.
- Type: Fittings with double compression ferrules & nuts.
- Material: 304
- Gas Service: Vacuum
- Working Pressure: 50 Bars

Testing Pressure of Pipeline:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Service</th>
<th>Design Pressure</th>
<th>Hydraulic Test Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vacuum</td>
<td>10 Bars</td>
<td>15 Bars</td>
</tr>
</tbody>
</table>

2.5 BASIS OF WORK, CODES & STANDARDS:

1. The complete piping work shall be carried out in accordance with Approved Drawings and standards and any drawings/documents prepared by contractor and duly approved by Engineer-in-Charge/Owner.

2. Released for Construction drawing and sketches issued by EPIL to contractor such as Piping and equipment layout plans.
2.6 STANDARDS & SPECIFICATIONS:

2. ASME Sec IX & IS: 814 Electrodes & filler wire etc.: Material Specifications, Welding rods, 
3. ANSI-B-16.5: Pipe Flanges & Flanged Fittings
4. ASME/ANSI-B-16.10: Face-to-Face & End-to-End
6. ASTM A 312 TP 304, Seamless: Pipes.
7. ASTM A 312 TP 304/ ANSI B 16.11/ 16.9: Pipe Fittings
8. IS Standard or Equivalent: Gauges

2.7 SPECIFICATIONS FOR PIPE JOINTS:

A PIPE JOINTS

1. In general joints shall be butt welded as specified in the applicable valve & piping Specifications, with flanges and butt weld fittings used wherever required.
2. Fabricated piping system shall be erected as detailed on piping layout drawing and as advised by the Engineer-in-Charge. The contractor shall provide adequate field joints bearing in mind the fact that there may be variations in locations of equipments, equipment nozzles, inserts, structures, etc. but not limited to the aforesaid contingencies only. In certain cases site measurement may have to be taken before commencement of fabrication.
3. Flange joints shall be used at connections to vessels, equipments, valves, flanged fittings and wherever required for ease of erection and maintenance as indicated in the drawings.

B EDGE PREPARATION

1. The edges to be welded shall be prepared to meet the joint design requirements by any of the following methods.
2. Plasma cutting, machining or grinding methods shall be used. After plasma cutting, cut shall be machined or ground smooth.
3. The edges prepared shall be as per ANSI-B-31.3.
The ends to be welded shall be properly cleaned to remove paint, oil, grease, rust, oxides, sand, earth or any other foreign material. The ends shall be completely dry before welding commences.

**C WELDING**

1. Welding of butt joints/socket weld joints, etc. has been broadly described in the "Welding Specification".

2. For stainless steel, welding shall be done using inert Argon gas shielded Tungsten Arc process and Dry Nitrogen as for purging.

**D STRUCTURAL STEEL**

1. The work covered consists of fabrication and erection of structural steel pipe supports in strict accordance with specification and applicable drawings.

**E WELDING SPECIFICATION**

1. All welding shall have full thickness penetration and shall be done by the TIG process. Tack welds lacking penetration shall be chipped out completely and re-welded properly.

2. In multiple pass welding, each layer shall be cleaned of all stag, scale and other foreign matter and any serious defects chipped out before subsequent welding is done. Next run of weld shall be carried out only after thorough inspection, rectification and preparation of the previous run. Use stainless steel chipping tools and wire brushes for cleaning.

3. The completed weld shall be cleaned of slag and spatter if any.

4. No under cutting of pipe adjacent to the completed weld shall be permitted.

5. Pipes shall be brushed with stainless steel wire brushes and then cleaned for a distance of at least 50mm from the weld area. Filler material shall also be cleaned in similar manner.

6. In order to get optimum benefit, carbide precipitation has to be avoided. Also it is essential to retain the high strength resulting from cold works. It is therefore, extremely important to control the temperature and duration of welding very effectively. By using purging and trailing gas of TIG welding and large current for extremely short periods of time in MMA welding, the desired optimum results may be achieved.

7. Root pass shall be made with electrodes/filler wires recommended in the welding specification chart. The preferable size of the electrode is 1.6 OR 2.5 mm diameters (12 SWG) but in any case not greater than 3.25 mm (10 SWG)

8. The root run of butt joints should be executed properly so as to achieve full penetration with complete fusion of the root edges. Weld projection inside the pipes shall not exceed 3mm, wherever not specified by the applicable code. All roots run shall be done by TIG welding for Butt Joints.
While welding is in progress, care should be taken to avoid any kind of movement of the components, shocks, vibrations and stresses to prevent occurrence of weld cracks.

Wherever grinding wheels are required for grinding purpose, for stainless steel suitable type of grinding wheels shall be used. Separate grinding wheels and wire brushes should be used for carbon steels and stainless steels.

Welding shall be free from undercuts and other defects.

Each weld joint should have workmen like finish.

**F ELECTRODES & FILLER WIRES**

Welding electrodes with a suitable coating/filler wires shall be in accordance with IS: 814/ASME Sec. II, latest edition and of a recognized quality. These shall be approved by Engineer-in-Charge before being used in the work. Approved makes are to be used. The contractor shall submit batch test certificate from the electrode manufacturer. The following specifications of electrodes are recommended for welding:

2. General structural welding : AWS-E-6013
3. Carbon Steel : AWS-E-6018/7018
4. Carbon Steel to stainless steel : AWS-E-309
5. Stainless Steel filler wire - AISI 304/316 : ER 304 / 308 / 316

All electrodes shall be purchased in sealed containers and stored properly to prevent deterioration. The electrodes removed from the containers shall be kept in holding ovens at temperatures and time recommended by the electrode manufacturer. Out of the oven, time of electrodes before they are consumed, shall not exceed the limits recommended by the electrode manufacturer. The electrodes shall be handled with care to avoid any damage to the flux covering.

**2.8 TESTING AND COMMISSIONING**

**Piping Network Testing**

All piping shall be hydrostatically tested for 1.5 times of design pressure after completion of fabrication.

**2.9 COLOR CODE FOR PIPING**

1. The colour code scheme is identified for identification of the individual service of the pipeline.
   - Vacuum : Yellow
2.10 Control Panel

Panel shall be fabricated from 2mm CRCA sheet steel. Degree of protection shall be IP54. Painting shall be powder coated with shade siemen grey. Panel shall be floor/wall mounting type with cable entry from top. Incoming shall be MCCB of suitable rating and out going starter should consist of MCCB, contactor, over load relay A/M selector switch, push button etc. Minimum rating of contactor shall be 25A, AC23 rating. Both the feeder shall be interlocked. Normally one pump shall run and if the pressure drops, both the pump shall run. Interconnecting cables shall be 1.1KV grade, XLPE with outer sheet PVC.

Earthing shall be provided inside the plant. Two separate GI plate earthing pits to be provided for connection to earthing inside plant. Control wiring shall be done with 2.5 mm² PVC flexible wires.

Drawings

The following drawings shall be submitted for approval after award of work:-
1) Layout showing pumps & tank.
2) Pumps drawings & data sheet.
3) Control scheme drawing /GA drawing of Panel.
4) Overall layout showing interconnection in each lab.

2.11 DRAWINGS

The routing of the vacuum system piping to various Laboratories is as per attached drawing.

<table>
<thead>
<tr>
<th>SR. NO.</th>
<th>DESCRIPTION</th>
<th>DRG. No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>P&amp;ID for Biological Laboratory Ground floor plan – Vacuum line</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>