BHARAT HEAVY ELECTRICALS LIMITED,
RANIPET- 632 406.

TECHNICAL SPECIFICATION

FOR

MIXED BED SYSTEM

For KPCL-III Project
PART-1

<table>
<thead>
<tr>
<th>Rev.No</th>
<th>Date</th>
<th>Prepared</th>
<th>Checked</th>
<th>Approved</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>13.07.13</td>
<td>IMRL RAO</td>
<td>PPALANI</td>
<td>S.KAILASAM</td>
<td>Fresh issue</td>
</tr>
</tbody>
</table>
## INDEX

<table>
<thead>
<tr>
<th>SECTION</th>
<th>DESCRIPTION</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SECTION - 1</td>
<td>SCOPE OF SUPPLY</td>
<td>4</td>
</tr>
<tr>
<td>SECTION - 2</td>
<td>PROJECT INFORMATION</td>
<td>7</td>
</tr>
<tr>
<td>SECTION - 3</td>
<td>TECHNICAL REQUIREMENT</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>- MB PLANT CAPACITY</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- INLET WATER QUALITY FOR DESIGN</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- OUTLET WATER QUALITY</td>
<td></td>
</tr>
<tr>
<td>SECTION - 4</td>
<td>TECHNICAL SPECIFICATION - MECHANICAL</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>- DESIGN CRITERIA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- TERMINAL POINTS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- EQUIPMENT SPECIFICATION</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- GENERAL DESIGN REQUIREMENTS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- PIPING</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- VALVES</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- PAINTING</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- VENDOR LIST</td>
<td></td>
</tr>
<tr>
<td>SECTION - 5</td>
<td>TECHNICAL SPECIFICATION FOR ELECTRICAL, CONTROLS &amp; INSTRUMENTATION</td>
<td>36</td>
</tr>
<tr>
<td>SECTION - 6</td>
<td>TECHNICAL DETAILS FOR CIVIL WORKS</td>
<td>36</td>
</tr>
<tr>
<td>SECTION - 7</td>
<td>PERFORMANCE GUARANTEE</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>- PERFORMANCE GUARANTEE</td>
<td></td>
</tr>
<tr>
<td>SECTION - 8</td>
<td>SPARES</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>- MANDATORY SPARES</td>
<td></td>
</tr>
<tr>
<td>SECTION - 9</td>
<td>ERECTION, COMMISSIONING, TRIAL OPERATION, PG TEST AND HANDING OVER</td>
<td>39</td>
</tr>
<tr>
<td>SECTION</td>
<td>DESCRIPTION</td>
<td>PAGE No.</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>SECTION – 10</td>
<td>DOCUMENTATION</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>DOCUMENTS TO BE SUBMITTED ALONG WITH BID</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DOCUMENTS TO BE SUBMITTED AFTER ORDER</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DOCUMENTS TO BE SUBMITTED BEFORE DESPATCH</td>
<td></td>
</tr>
<tr>
<td>SECTION - 11</td>
<td>ATTACHMENTS</td>
<td>42</td>
</tr>
</tbody>
</table>
1.0 : SCOPE OF SUPPLY & SERVICES

1.1 The intent of this specification is to cover Design, Engineering, Manufacturing, Shop Testing, Supply, Transportation, Erection & Commissioning and PG (Performance Guarantee) Test. Further, O&M for three months after PG Test based on BHEL notification and handing over of the following systems.

- **DE-GASSER SYSTEM**
- **MIXED BED (MB) SYSTEM**
- **MB REGENERATION SYSTEM**
- **BULK STORAGE SYSTEM**

The scope shall fully cover the requirement of the Design Criteria and Technical requirement of this specification for treating the permeate water from Reverse Osmosis (RO) Desalination Plant to meet the boiler makeup water quality requirement. The scope shall include but not limited to the following:

a. 1 x 100% MSRL Degasser tower with all internals & accessories
b. 1 x 100% MSRL Degassed Water Storage Tank (20 m³).
c. 2 x100% (1W + 1S) of Degasser Blowers with motors, Air filter box (suction) & accessories, interconnecting piping / ducts and valves from blowers to degasser tower.
d. 1 x 100% (1W) MB Unit along with all accessories, internals,
e. 1 set of Cat ion & anion resin for MB system
f. 2 x 100 % (1W+1S) Mixed Bed (MB) feed pumps with motors and all accessories.
g. 2 x 100% (1W+1S) MB regeneration Pumps with motors and all accessories
h. 2 x 100% (1W+1S) MB Blowes with motors and all accessories for MB regeneration
i. 1 x 100% Acid Measuring Tank (AMT), ejector & acc. etc for MB regeneration
j. 2 x 100% (1W+1S) Caustic Dilution Tank (CDT) with agitators, ejector & acc. etc. for MB regeneration.
k. 1 x 10m³ Bulk Acid Storage Tank (MSRL) with 2 x 100% acid unloading pumps with motors along with interconnecting piping & accessories.
l. 1 x 10m³ Bulk Caustic Storage Tank with 2 x 100% caustic unloading pumps with motors along with interconnecting piping & accessories.
m. 1 set of MB frontal piping & valves along with pneumatic operated diaphragm actuator.
n. 1 set of interconnecting piping system including valves and accessories etc. for the following areas:
   - Degasser system to MB feed pumps
   - Degasser blowes to degasser
   - MB feed pumps to MB vessel
   - MB blowes to MB vessel
SPECIFICATION FOR MIXED BED SYSTEM

- MB regeneration pumps suction piping from DM Water storage tank upto pumps
- MB regeneration pumps discharge to MB system
- Piping for bulk chemical storage system (unloading pump to tanks & from tanks to AMT/CDT)
- AMT/CDT area to MB system.
- MB outlet piping from vessel to outside of RO-DM plant building.

  o. 1 set of necessary foundation bolts with fasteners for all the equipments.
  p. 1 set of Electrical, Controls & Instrumentation as per specification & PID & ROS 4054.
  q. 1 set of miscellaneous items including fasteners, gaskets, ladders, MB platforms, supports for piping and valves.
  r. 1 set of Mandatory spares.
  s. 1 set of Erection & Commissioning, trial operation and PG Test (Refer Section 9.0)
  t. O&M for three months after PG Test or based on BHEL notification (Refer Section 9.0)
  u. One set of O/M tools.

The permeate water from RO 2nd stage shall be degasified in the Degasser tower (DGT) and stored in a Degassed water storage tank (DWST). The Degassed water stored in the degassed water storage tank shall be pumped by MB Feed Pumps to mixed bed to meet the **boiler make-up water quality**. Necessary regeneration system shall be included in the MB system package for regeneration of MB resins. Bulk storage tanks & Unloading pumps for chemicals are included in the bidder's scope. Preliminary drawings for P&ID & Layout for the MB system are enclosed (as referred in section-11) for further reference. These drawings are subject to the approval of the customer. There may be some minor variation in the scope as per the requirement of BHEL's customer. System Vendor shall take care of these variations during execution without any additional financial implications to BHEL.

1.1 **Items though not mentioned but needed to make the system complete in all respects as stipulated under these specifications are also to be supplied without any commercial implication unless otherwise specifically excluded.**

1.2 It is not the intent to specify all the details of the design & manufacture. However, the equipment shall conform in all respects to high standard of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to Engineer / Owner, who will interpret the meaning of drawing & the specification and shall be entitled to reject any work or material, which is not in full accordance herewith.
1.3 General terms & conditions, instructions to the tenderer & other attachments referred to elsewhere are also part of this specification.

1.4 The order of priority of this specification is as follows.
   a. Equipment Specification,
   b. Scheme drawing and
   c. General design requirements

1.5 **Resin supply packing shall be made in drums only.** Resin supply in HDPE bag is not acceptable.

1.6 Bidder shall submit their total shipping list and Quality Plan for BHEL approval well in advance.

1.7 Vendor to submit the commercial offer for complete package with break a up for

**Part-1.** Design, Engineering, Manufacturing, shop testing, supply to BHEL stores at site.

**Part-2.** Collection of materials / equipment from BHEL site stores, transportation to erection spot, erection of the complete Degasser system, MB system, MB Regeneration System & Bulk Storage System, stage clearance, testing, commissioning, trial run & performance guarantee test, handing over and O & M for months.

Separate order will be released for part – 1 & part – 2 for the successful bidder.

**NOTE**

1. Successful commissioning means, erection of entire system, trial run / trial operation till achieving the performance both in terms of Quality (including electrical power consumption) and Quantity to prove the agreed performance of the system and the system is ready for PG Test. Once this stage is reached, Vendor will inform to BHEL that they are ready for PG Test. If BHEL Engineer is satisfied in commissioning, PG test can be conducted within 30 days from the date of such notification by Vendor to BHEL and till such time the running of the system to be taken care of by the vendor. Conduct of PG Test shall be the responsibility of the Vendor. Vendor to submit PG test procedure along with PG test request to BHEL for BHEL approval. The notification date (30 days) will start only after the approval of procedure by BHEL. Necessary consumables and chemicals required for the trial run / trial operation till PG Test will be provided by BHEL at free of cost to Vendor. However, the requirement of consumables and chemicals details is to be provided well in advance before commissioning by the Vendor to BHEL, failing which the vendor has to arrange for the chemicals.
2. Vendor to quote O&M Charges on monthly basis for O&M of the plant after conducting the PG Test of the system. O&M order will be for a minimum period of 3 months. However, the period of O&M will be extended till the requirement by BHEL. The requirements for O&M viz. Power, Spares, Chemicals, Consumable required for the O&M of the system will be provided by BHEL at free of cost to Vendor. However, the requirement of Power, Spares, Chemicals, Consumable details is to be provided well in advance before commissioning by the Vendor to BHEL.

2.0: PROJECT INFORMATION

Owner : Karnataka Power Corporation Ltd. Bellary.
Project Title : KPCL-III, BELLARY – 1x700 MW
Location : Kudatini
Nearest Rly Station : Bellary Railway station
Site address : The Construction Manager,
BHEL Site office,
Bellary Thermal Power Station Unit#3, 1x 700 MW , Kudatini Village,
Bellary District,
Karnataka-583115.
3.0 : TECHNICAL REQUIREMENT

3.1 MB PLANT CAPACITY

MB unit shall be capable of producing Boiler Make-up water of required quality using design inlet water quality, specified in this specification, with the net output capacity of 75 cu.m/hr on continuous operation basis. The net output between regeneration (OBR) continuous operation basis shall be 7200 cu.m in 4 days (96 hrs).

a. No of streams of the MB system = 1 Working
b. Net output capacity of MB system = 75 cu.m / hr
c. Net output between regeneration of MB system = 7200 cu.m
d. Net output capacity of MB system = 75 cu.m / hr

3.2 INLET WATER QUALITY FOR DESIGN OF MB SYSTEM

The inlet water quality to be considered for design is from 2nd stage (permeate staging) RO system and the analysis is indicated below.

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Parameters</th>
<th>Unit</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td></td>
<td>4.8 - 5.2</td>
</tr>
<tr>
<td>2</td>
<td>Conductivity</td>
<td>µS./cm</td>
<td>22.0</td>
</tr>
<tr>
<td>3</td>
<td>Temperature - Design</td>
<td>deg C</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>- Min &amp; Max</td>
<td>Deg C</td>
<td>25 &amp; 35</td>
</tr>
<tr>
<td>4</td>
<td>Total dissolved Solids</td>
<td>mg/l</td>
<td>&lt;12</td>
</tr>
<tr>
<td>5</td>
<td>Carbon di Oxide as CO2 - Design</td>
<td>ppm</td>
<td>100 *</td>
</tr>
<tr>
<td>6</td>
<td>Carbon di Oxide as CO2 - Maximum</td>
<td>ppm</td>
<td>120 *</td>
</tr>
<tr>
<td>7</td>
<td>SiO2 as SiO2</td>
<td>ppm</td>
<td>0.4</td>
</tr>
<tr>
<td>8</td>
<td>Sodium as Na</td>
<td>ppm</td>
<td>3.0</td>
</tr>
<tr>
<td>9</td>
<td>Potassium as K</td>
<td>ppm</td>
<td>0.1</td>
</tr>
<tr>
<td>10</td>
<td>Calcium as Ca</td>
<td>ppm</td>
<td>0.6</td>
</tr>
<tr>
<td>11</td>
<td>Magnesium as Mg</td>
<td>ppm</td>
<td>0.1</td>
</tr>
<tr>
<td>12</td>
<td>Bicarbonate as HCO3</td>
<td>ppm</td>
<td>4.5</td>
</tr>
<tr>
<td>13</td>
<td>Chloride as Cl</td>
<td>ppm</td>
<td>3.3</td>
</tr>
<tr>
<td>14</td>
<td>Sulphate as SO4</td>
<td>ppm</td>
<td>0.1</td>
</tr>
<tr>
<td>15</td>
<td>Nitrate as NO3</td>
<td>ppm</td>
<td>0.2</td>
</tr>
<tr>
<td>16</td>
<td>Fluoride as F</td>
<td>ppm</td>
<td>0.0</td>
</tr>
</tbody>
</table>
NOTE:
* The CO2 indicated is at the First stage RO permeate water. The degasser to strip the CO2 is also included in scope of supply along with Mixed Bed System.

3.3 OUTLET WATER QUALITY:
The plant design should meet the outlet water quality as indicated below.

### 3.3.1 DEGASSER OUTLET WATER QUALITY

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Description</th>
<th>Unit</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Carbon di Oxide as CO2</td>
<td>ppm</td>
<td>&lt; 5.0 ppm at max flow rate</td>
</tr>
</tbody>
</table>

### 3.3.2 MIXED BED OUTLET WATER QUALITY

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Description</th>
<th>Unit</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td></td>
<td>6.8 to 7.2</td>
</tr>
<tr>
<td>2</td>
<td>Conductivity at 25 deg C</td>
<td>µS/cm</td>
<td>0.1 max</td>
</tr>
<tr>
<td>3</td>
<td>Silica as SiO2</td>
<td>ppm</td>
<td>0.015 max</td>
</tr>
<tr>
<td>4</td>
<td>Organic matter</td>
<td>ppm</td>
<td>Practically Free (less than 0.2 mg of KmnO4/Lt)</td>
</tr>
</tbody>
</table>
4.0: TECHNICAL SPECIFICATION - MECHANICAL

4.1 DESIGN CRITERIA

The Mixed Bed (MB) unit shall be of automatic operation (but in case of regeneration, initiation shall be done manually and sequence of operation shall be automatic). The RO Stage -1 permeate water supplied from Desalination Plant shall be treated in RO Stage -2 and the permeate water supplied shall be treated in Degassing System comprising of 1 x 100 % Degasser Tower, 2(1W+1S) x 100% Degasser Blowers and 1 x 100% Degassed Water Storage Tank. The degassed water shall be collected in a degassed water storage tank (MSRL-20cu.m). The degasser tower shall be mounted on the degasser water storage tank.

As the feed water to the degasser will be directly connected from the membrane permeate outlet-having limitations of backpressures (1.0 bar maximum), bidders have to limit the degasser tower height to less than 3 meters.

The Degassed water shall be pumped through MB Feed pumps (1W+1S) to 1-stream of MB Unit. The MB unit shall be sized to meet the guaranteed output quality and quantity as called for in the specification.

A regeneration system shall be included in the design to regenerate the single mixed Bed unit. It shall consist of regeneration pumps (1W+1S) and 1 no. of AMT (1W) & 2 nos. of CDT (1W+1S) chemical tanks (measuring tanks), ejectors and MB regeneration blowers (1W+1S), along with required accessories separately for acid and alkali from bulk storage tank (pipe routing approximately about 70 m distance) outlet. Please refer to the equipment layout for attached with this specification. The design shall take care of the collection of regeneration effluent, all drains of the plant at a common trench in the MB unit.

Necessary piping, pneumatic and manual operated valves, impulse tubing & accessories, instrument air line distribution for POV’s, cabling between junction box to respective instruments / equipment’s thro’ cable trays, pneumatic operated diaphragm valves, limit switches, instruments, controls & Interlocks shall be provided in the system for auto operation and also as per the preliminary P&ID drawing enclosed along with this specification. The piping, impulse lines, cables, trays etc. shall be routed, installed suitable to have easy accessibility and aesthetic look.

The details of the equipment / system are elaborated in respective section of this specification.
4.2 TERMINAL POINTS:

P&ID and Scope and terminal point details are indicated in the enclosed drawing No : 1-WT-220-00253  Rev.00 with this specification.

a. Feed water ( RO permeate – 2\textsuperscript{nd} stage) will be supplied by the customer (BHEL) at the inlet of degasser tower flange.

b. One suction nozzle (flooded) with flange (ANSI B 16.5, 150 class) of suitable size will be provided at RO 2\textsuperscript{nd} stage permeate outlet by the customer (BHEL) we will specify the size. Further interconnecting piping, valves, fasteners (bolt, nut with two washers), instrumentation, etc., from this flange to MB system will be in vendor's scope. Bidder to specify the required nozzle size after order. Vendor shall study the preliminary layout and P&ID drawings and consider sufficient length of piping with reserve.

c. Outlet DM water piping from MB system shall be terminated by the vendor at a common point, with flanged end along with dummy flange and fasteners nearer to the RO-DM plant (at a distance of 5 meter from RO-DM plant. The outlet pipe size shall be of DN 200 (min), schedule 10, SS 316L and the required outlet pressure is 2 bar (g). Further piping to DM water tank is under BHEL’s scope. Flange shall be as per ANSI 16.5 #150.

d. The MB regeneration pumps location is away from MB system, at a distance of approximate piping around 170m. Hence vendor to consider additional 1 bar (g) as extra head over and above the calculated regeneration pump discharge head requirement by considering the above distance. One suction nozzle (6” NB) with flange, with flooded suction will be made available at DM water regeneration pump house boundary. Necessary interconnection suction / Discharge piping of MOC-MSRL from pump delivery flange to respective AMT/CDT & power water for the regeneration system including, valves, instrumentation, piping supports etc to the MB system are in bidder’s scope. Bidder has to accommodate any minor variation in the length without any additional cost. Concrete pedestal for pipe support is not in bidder’s scope.

e. Required instrument air piping with an isolation valve will be made available by BHEL at one common point near the MB system building/Regeneration Pump House building boundary. Bidder shall indicate the requirement of the instrument air in their offer. All the air filters required for the efficient operation of the instruments in the system are in bidder’s scope.
f. The required chemicals (HCl & NaOH) for MB regeneration will be made available at bulk storage tank which is installed about 70 m approximately distance away from MB boundary line. Vendor shall verify the actual distance from the drawing and provide necessary reserve for execution. Piping from unloading pumps to Bulk storage tank & from Bulk Storage tanks to AMT/CDT and then to the MB system shall be in the bidder’s scope. Bidder shall indicate the requirement of these chemicals in their offer. Piping from Unloading pump to Bulk storage tank & from Bulk Chemical Storage System to AMT/CDT shall be of CPVC SCH 80. Similarly piping from AMT/CDT to MB vessel shall be of MSRL. Concrete pedestal for pipe support is not in bidders scope.

[Technical grade Hydrochloric Acid (HCl) 30 to 33% conc. as per IS-265 and Rayon grade Sodium Hydroxide (NaOH) lye 48% conc. alone will be provided by the purchaser for MB regeneration chemical requirement]

g. Necessary interconnection suction / Discharge piping of MOC-MS from delivery flange of degasser blowers to degasser including, valves, instrumentation, piping supports etc are in bidder’s scope.

h. Necessary interconnection suction / Discharge piping of MOC-MSRL from delivery flange of MB Feed pumps to MB Vessel including, valves, instrumentation, piping supports etc are in bidder’s scope.

i. Necessary interconnection suction / Discharge piping of MOC-MS from delivery flange of MB blowers to MB Vessel including, valves, instrumentation, piping supports etc are in bidder’s scope.

j. The DM water shall be provided by BHEL at the common suction of MB regeneration pumps(DN 150) with a flange. The common suction piping & valves for Mb regeneration pumps are in bidder’s scope.

k. Necessary civil works like equipment foundation with pockets, acid resistant tiling in the AMT, CDT area, trenches etc., are excluded from the bidder’s scope. However bidder shall provide the details in their offer. All necessary foundation bolts for all equipment, such as MB unit, Degasser towers, blowers, pumps, AMT/CDT, etc., are in the scope of the vendor. This shall be made as first dispatch before the equipment is being despatched.

l. All fasteners are to be of SS 304 only (except foundation bolts).

m. Mixed bed regeneration effluent and drain etc. shall be terminated separately by bidder in the nearby RCC trenches. The entire required pipes including laying, supports etc. for this are in bidder’s scope. Further disposal will be done by BHEL by gravity.
n. EC&I items shall be as per the ROS:4054 Rev.00.

o. Electrical power supply from the control panel will be provided by the purchaser at the terminal block of each motor. Bidder has to provide the list of drives along with the bid. Terminal blocks with cable gland are in bidder’s scope and the cable gland & lugs shall be despatched as a separate item in a box.

p. The instrument cables from the instruments to the junction boxes are in the scope of bidder. Further cabling from junction box to PLC/DCS is in the scope of customer. Junction boxes are in the scope of bidder.

4.3 EQUIPMENT SPECIFICATION - Mechanical

The technical requirements of the equipments are indicated below. In addition, the applicable P&ID and Layout enclosed with this specification shall be referred.

4.3.1 DEGASSER TOWER

a. Application : To reduce CARBON DI OXIDE level in the RO permeate water.

b. Quantity : 1 x 100%

c. Operation : Continuous.

d. Installation : Mounted on the top of Degassed water storage tank.

e. Type : Vertical tower type & forced draught.

f. Inlet water flow : 76 m³/hr (min)

g. Air to water ratio : 25 m³/m³ (min)

h. Specific Velocity of water : 60 m³/hr/m² (max)

i. DGT air vent velocity : 6 m/sec (max)

j. Shell thickness & Height : Min.6.0 mm & approx. 3.0 m

k. Packing height : 2.0 m (min)

l. Material of Construction- Tower : IS-2062 Gr-A.

   -Rasching Ring : Polypropylene.

   - Grid : FRP

m. Internal protection : Rubber lining 4.5 mm thick as per IS 4682 & shore hardness 65 ± 5 Gr.A

n. Inlet design water quality : As per section 3.2 for Maximum CO2 level

o. Guaranteed Outlet water quality : As per section 3.3

p. Degasser inlet nozzle Elevation : ~7 meter maximum from Ground Level.

q. Design Code : IS 803

r. Hydraulic Test Pressure : 1.5bar

s. Accessories : All the ladders, platforms, pipe supports are in vendor’s scope.
4.3.2 DEGASSER BLOWER WITH MOTOR

a. Application : To supply air to Degasser Tower  
b. Quantity : 2 x 100 % (1 Working +1 Standby)  
c. Operation : Continuous  
d. Type : Centrifugal,  
e. Installation : Indoor in MB Building  
f. Flow : Bidder to Specify  
g. Head : Bidder to Specify  
h. Accessories : Silencers, Non return valve, Pulleys with V belts & guard, Base frame, Pr. Relief valve, Suction filter, pressure gauge, anti-vibration Mountings, flexible discharge connection etc.  
i. MOC - Blower casing & impeller : MS  
j. Shaft & Sleeve : EN 8 /ASTM A 321 & ASTM A276 TP316  
k. Motor : As per Electrical Spec. 

4.3.3 MIXED BED VESSEL UNIT

a. Application : To generate the Boiler make-up water from degassed RO Permeate water.  
b. Quantity : 1x 100 % (1 W)  
c. Type : Vertical, Cylindrical  
d. Feed water quality : Degassed water outlet quality in section3.3.1  
e. MB Outlet quality : As per Section – 3.3.2  
f. Net guaranteed output, m3/hr : 75  
g. OBR m3: 7200 between two successive regeneration  
h. Continuous Operating hours hrs : 96 (between two successive regeneration)  
i. Regeneration time hrs : 4 (max)  
j. Material : IS - 2062 Gr-A or Equivalent.  
k. Internal protection : Rubber lining 4.5 mm thick  
   (two layers of thickness : 2.2+2.3) as per
IS 4682 & Shore hardness 65 ± 5 Gr. A

l. Design Code : IS 2825
m. Design Pressure : 6.0 bar (g) minimum.
n. Test Pressure : 1.5 times of Design Pressure
o. Vessel dia m : 2.4 approx. (Vendor to specify)
p. Vessel shell thickness mm : 10 (min) – to be as per IS 2825
q. Vessel dish thickness mm : 14 (min) – to be as per IS 2825
r. Resin bed height : Minimum 0.5 m for Cation resin,
                  Minimum 1.0 m for Anion resin.
                  Or the minimum recommended in respective resin literature whichever is higher.
                  However bidder to select increased resin bed height if required to meet the design ionic load.

(For the calculation of resin volume in all ion exchange units, ion exchange vessels sizing etc. 10% (ten percent) deration factor on corrected exchange capacity, as obtained from characteristic curves, shall be considered to provide margin towards ageing of resins. Resin calculation must be provided; Otherwise offer will be rejected).
s. Free Board : 100% of bed height
t. Surface flow rate m³/hr/m² : > 10 and < 25
u. Acid available for regeneration : ~ 30% HCl, technical grade as per IS 265
v. Alkali available for regeneration : ~ 48% NaOH rayon grade as per IS 252
w. Resin life : Minimum 3 years for Anion resin &
               Minimum 5 years for Cation resin.
x. Attrition loss of resins: Cation : 3% per annum (max)
               Anion : 5% per annum (max)
y. Resin type
   Cation : High capacity premium, strongly acidic,
            Sulphonated polystyrene base, Cation exchange resins.
   Anion : Strongly basic polystyrene base
            macroporous type-I anion exchange resins.
            The anion resin shall be able to withstand a
temperature of 60 deg C. **Type II resin will not be accepted.**

Resin make: Ion Exchange / Rohm & Hauss / Dow

z. Accessories: Necessary Resin traps for normal water outlet and regeneration water outlet, resin removal nozzles (minimum dia 100 NB), distributor nozzles, inlet / outlet / regeneration nozzles, drain, vent, necessary sight glass (3 nos – MOC of Borosilicate toughened glass) of clear width not less than 75 mm, for viewing resin level, pneumatic operated valves for automatic operation / regeneration, access ladder with safety cage, handrails at vessel top, two (2 nos) davit type manholes (dia 500 mm size minimum) davit type and an access below the bed plate (ie. strainer on plate) etc.

aa. Support Legs:

Quantity: 4 Nos.
Size: Minimum 200 NB pipe, Carbon steel, Sch 80 pipe with necessary gusset plates for reinforcement.
Base Plate: ~ 350 x 350 x 20 (L x B x thick)(minimum)

ab. Thinning allowance for dished ends: 2.0 mm (min.)
ac. Corrosion allowance for shell & dish end: 1.5 mm (min)
ad: All fasteners for vessel internal & sight glass and manholes: SS 304
ae. Bottom collector assembly: Strainer on plate.
The bottom plate thickness must be minimum of 20 mm with necessary bottom supports or calculated thickness whichever is higher.

4.3.5 MIXED BED BLOWER WITH MOTOR

a. Application: To supply air to MB during regeneration.
b. Quantity: 2 x 100 % (1 W + 1S)
c. Operation: Intermittent
d. Installation: Indoor near Mixed Bed Building
e. Type: Positive displacement - Twin Lobe
4.3.6 MIXED BED FEED PUMPS WITH MOTOR

a. Application : To feed water to Mixed Bed units
b. Quantity : 2 x 100 % (1 W + 1S)
c. Operation : Continuous
d. Installation : Indoor
e. Type : Centrifugal, Horizontal
f. Suction : From Degassed Water storage tank
g. Discharge Flow rate, m³/hr : Bidder to select with 5% margin minimum.
h. Discharge head, mWC : Bidder to select with minimum 10% margin
   above the requirement. The head requirement to be calculated by considering
   the losses through resin bed, piping, valves,
   orifice etc. in the MB system plus 2 bar (g)
   pressure at MB final outlet terminal point.
i. Speed, rpm : 3000 (max)
j. MOC of all wetted parts : SS 316
   Casing
   Impeller
   Shaft : SS 410 / SS 329
   Shaft sleeve : SS 316
k. Shaft Seal : Mechanical – API plan 11
l. Coupling : Flexible coupling (Spacer type) with Guard
m. Base frame for Pump & Motor mounting : Carbon steel with epoxy coated.
n. Bearing : Anti-friction
o. All fasteners : SS316
p. Motor : As per Electrical Specification
4.3.7 MIXED BED REGENERATION PUMPS WITH MOTOR

- **Application**: To supply DM water from DM water storage tank to Mixed Bed system
- **Quantity**: 2 x 100% (1 W + 1S)
- **Operation**: Intermittent
- **Installation**: Indoor
- **Type**: Centrifugal, Horizontal
- **Suction**: From D.M. Water storage tank
- **Discharge Flow rate, m3/hr**: Bidder to select with 10% margin
- **Discharge head, mWC**: Bidder to select with minimum 10% margin above the head required. The head requirement to be calculated by considering all losses in the MB system plus frictional loss of 70 m pipe segments whichever is higher at MB inlet terminal point. Bidder to specify the pipe size & pressure rating for all the pipelines & headers.
- **Speed, rpm**: 3000 (max)
- **MOC of all wetted parts**
  - Casing: SS 316
  - Impeller: SS 410 / SS 329
  - Shaft: SS 316
  - Shaft sleeve: SS 316
- **Shaft Seal**: Mechanical – API plan 11
- **Coupling**: Flexible coupling (spacer type) with Guard
- **Base frame for Pump & Motor mounting**: Carbon steel with epoxy coated.
- **Bearing**: Anti-friction
- **All fasteners**: SS 316
- **Motor**: As per Electrical Spec.

4.3.8 MB REGENERATION SYSTEM: 1 Set consisting of **three** Tanks & accessories

- **Tanks**
  - Acid measuring Tank (AMT): 1 nos
  - Alkali measuring Tank (CDT): 2 nos (1W+1S)
- **MOC**: MSRL
- **FRP With UPVC/PP linings**
- **Tank thickness for MS**: 6.0 mm (min)
### for FRP

- Fume absorber: 1 no. not applicable
- Fume absorber- MOC (HDPE is not acceptable)
  - FRP / MSRL
- Internal protection: FRP tanks with UPVC/PP lining minimum 3 mm thick. Rubber lining 4.5 mm thick as per IS 4682, shore hardness 65 ± 5 Gr. A for MSRL tanks.

b. **Accessories**

: Ejectors, piping, valves, mixers & safety showers with eye-wash, Fume absorber for AMT etc.,

---

### 4.3.9 BULK ACID STORAGE (HCl) STORAGE SYSTEM

- **Tanks**
  - Bulk Acid storage
- **Medium used**
  - 30 to 33 % Hydrochloric Acid
- **Location**
  - Outdoor
- **Quantity**
  - 1 no.
- **Capacity (usable volume)**
  - 10 m$^3$
- **MOC**
  - MSRL
- **Type**
  - Horizontal, Cylindrical with dished ends
- **Pressure**
  - Atmospheric
- **Design Code**
  - BS:2594
- **Tank dia**
  - 2.0 m (min) (inside)
- **Tank shell thickness**
  - 10.0 mm (min)
- **Thinning allowance for dished ends**
  - 2.0 mm
- **Corrosion allowance for dished ends**
  - 1.5 mm
- **Internal Protection**
  - Rubber lining min. 4.5 mm thick (two layers of thickness: 2.2+ 2.3) as per IS 4682, shore hardness 65± 5 Gr. A
- **External protection**
  - As per BHEL spec. section 4.7
- **Piping, Valves & Fittings**
  - CPVC
- **Tank Nozzle flange thickness**
  - 15.0 mm (min)
- **Piping & fittings**
  - CPVC
- **Valves**
  - CPVC
- **Accessories**
  - Each tank consists of necessary manholes, inlet / outlet / drain & vent nozzles, piping, valves, level indicator, level switch, access ladder with safety cage, top platform, hand rails for manhole access, safety showers, eyewash etc. Suitable
handling arrangement / lifting lugs are to be provided in the tank for easy movement.

u. Hydro test: The tank shall be hydro tested up to 2.0 bar

The height of the pedestals shall be 5.0 m from FGL (This is for piping & valves estimation)

4.3.10 HYDROCHLORIC ACID (HCl) UNLOADING PUMPS

a. Application: To unload liquid HCl of 30 to 33% solution from tanker lorry at road.
b. Quantity: 2 No (1 W + 1S)
c. Discharge Flow rate, m3/hr: 10
d. Discharge head, M of WC: 25
e. Operation: intermittent
f. Installation: Outdoor
g. Type: Centrifugal, Horizontal
h. Suction: From tanker lorry
j. Shaft Seal: Mechanical seal – API plan 11
k. MOC of all wetted parts: PP / FRP
l. Bearing: Anti-friction
m. Coupling: Flexible coupling (Spacer type) with Guard
o. Accessories: Suction pipe / rigid hose 10 m minimum, Suction strainer (Y-type), drain and vent valves, delivery piping to storage tank and flushing arrangement piping for the flushing of the pump after unloading the chemical etc. The operation of the pump shall be controlled by the level switch in the tank (pump shall be stopped before the tank overflows)
p. Valves & strainers: CPVC
q. All fasteners: SS316
r. Motor: As per specification ROS: 4044

4.3.11 BULK ALKALI (NaOH) STORAGE SYSTEM:

a. Tanks: Bulk Alkali storage
b. Medium used: 48 % Sodium Hydroxide chemical
c. Location: outdoor
d. Quantity: 1 no.
e. Capacity (usable volume): 10 m³
f. MOC: MSRL
g. Type : Horizontal, Cylindrical with dished ends
h. Pressure : Atmospheric
i. Design Code : BS-2594
j. Tank dia : 2.0 m (min. inside)
k. Tank shell thickness : 10.0 mm (min)
l. Thinning allowance for dished ends : 2.0 mm
m. Corrosion allowance for dished ends : 1.5 mm
n. Internal Protection : Rubber lining min. 4.5 mm thick (two layers of thickness: 2.2+ 2.3) as per IS 4682, shore hardness 65 ±5 Gr. A
o. External protection : As per BHEI spec. section 4.7
p. Piping, Fittings : CPVC
q. Tank Nozzle flange thickness : 15.0 mm (min)
r. Piping & fittings : CPVC
s. Valves & strainers : CPVC
t. Accessories : Each tank consists of necessary manholes, inlet / outlet / drain & vent nozzles, piping, valves, level indicator, level switch, access ladder with safety cage, platform, hand rails for manhole access, safety showers, etc. Suitable handling arrangement / lifting lugs are to be provided in the tank for easy movement.
u. Hydro test : The tank shall be hydro tested upto 2.0 bar
v. The height of the pedestals shall be 5.0 m from FGL (This is for piping & valves estimation)

4.3.12 SODIUM HYDROXIDE UNLOADING PUMPS

a. Application : To unload liquid Sodium Hydroxide 48% from road tanker
b. Quantity : 2 Nos (1 W + 1S)
c. Discharge Flow rate, m3/hr : 10
d. Discharge head, M of WC : 25
e. Operation : intermittent
f. Installation : Outdoor
g. Type : Centrifugal, Horizontal
h. Suction : From tanker lorry
j. Shaft Seal : Mechanical seal – API plan 11
k. MOC of all wetted parts : SS 316 / SS 304
l. Bearing : Anti-friction
m. Coupling : Flexible coupling (Spacer type) with Guard
n. Base frame for Pump & } : Carbon steel with epoxy coated.
Motor mounting \}
\begin{itemize}
  \item Suction pipe / rigid hose 10 m minimum,
  \item Suction strainer (Y-type), drain and vent valves,
  \item Delivery piping to storage tank and flushing
  \item Arrangement piping for the flushing of the pump
  \item After unloading the chemical etc.
\end{itemize}

The operation of the pump shall be controlled
by the level switch in the tank (pump shall be
stopped before the tank overflows)

p. Valves & strainers : CPVC
q. All fasteners : SS316
r. Motor : As per specification ROS:4044.

\section*{4.3.13 PIPING AND VALVES}

a. Piping : Refer section 4.5
b. Valves : Refer section 4.6

\section*{4.4 GENERAL DESIGN REQUIREMENTS}

The common requirements for the system are stated in the general design
requirements. However the requirements indicated in the equipment specification
section 4.3 shall be strictly complied with.

\subsection*{4.4.1 COMMON REQUIREMENTS FOR ALL SYSTEM:}

1. Only latest revision of standard shall be used.

2. The design pressure of pressure vessel shall be minimum 5% higher than the
pressure experienced in the system like pump shut-off operation, higher operating
pressure at allowable electrical supply variations etc.

3. All the rotating equipments noise level shall be < 85db measured at 1 meter distance
from the equipment.

4. The tanks coming in contact with corrosive fluids should be rubber lined as indicated
in the specification for mechanical equipments.

5. All carbon steel pipelines unless otherwise specified elsewhere-carrying corrosive
fluids should be rubber lines inside to a thickness of at least 3.0 mm (2 layers).
6. The minimum thickness of carbon steel plates for shell and dish end of vessels shall be 6.0 mm. No thinning is allowed.

7. The design temperature of all vessels shall be taken as minimum **65 deg C**.

8. Sampling connections and air vent at the top most point of piping and vessels shall be provided at all stages of the Unit.

9. The size of the overflow pipes of all storage tanks shall be one size higher than inlet pipe sizes of these tanks.

10. Motor rating shall be minimum of **116%** of the duty point requirement and also to meet the maximum power requirement over the operating range at 50 Hz frequency.

11. Necessary access to be provided for all manholes & sight glasses.

12. All valves and piping shall be supported suitably with cushion/ rubber sheet of suitable thickness & bolted with “U” clamp. The supporting truss must have minimum width of 1.5 times of the pipe diameter and base plate of thick of 12 mm (minimum).

13. Providing of structural supports by raw material supply & fabrication suitably at site for DM water piping from DM water storage tank to MB, regeneration water piping from regeneration pump to MB, AMT/CDT & bulk chemical transfer piping from bulk storage tanks to AMT/CDT are under the scope of bidder.

14. Suitable platforms, walkways, stairways, cage type ladders etc. for access to all equipment shall be provided by the bidder.

15. All platforms and stairways shall have minimum clear width of 800 mm. All platforms, stairways, landings etc. shall have railings and guards. Platform for interlinking all vessels with cage-ladders shall be provided for more than one vessel. The ladders & platforms shall have handrails for safe climbing and access. All the manholes shall have ladder for approach and platforms for landing.

16. All metallic valves shall be rubber lined

17. All the valves are to be located to facilitate easy accessibility and operation from the ground level.

18. All the pipeline flange fasteners shall be SS316 with 2 sets of washers.

19. Vessel Internal supporting cleats shall be of SS316.

20. The direction of Flow shall be indicated by an arrow at regular intervals on all pipelines with luminous paint / luminous permanent stickers. The size of arrow shall be suitably selected so that it shall be visible from any direction.
21. All the equipments, valves & other items / components shall be tagged with corresponding KKS number as per PID. KKS number will be informed during execution stage.

22. Name of all vessels, tanks and tank capacity shall be painted on the respective vessel/tank prominently (after erection) with letter size of at least 150 mm tall by means of stencil.

23. Free board shall be provided over resin bed, below the backwash outlet nozzle and in straight portion of vessel to allow for expansion during backwashing.

24. All the ion exchanger vessels shall be provided with additional nozzles with flange for hydraulic transfer of resin as and when necessary arises. The nozzle shall be provided with manual valves of 100 mm NB. Dummy flanges, gaskets and fasteners are bidder's scope.

25. The guaranteed conductivity value must be attained after completion of regeneration and / or during fast rinse of one hour duration maximum.

4.4.2 Vessels & Tanks

All vessels & tanks except those specified otherwise shall be made of steel with suitable rubber lining. All steel tanks furnished by the bidder shall be designed suitable for operating condition. All pressure vessels shall be designed and tested to withstand 1.5 times of the design pressure. All the tanks shall be provided with suitable supporting legs, inlet and outlet connections, hand hole, manholes, nozzle connections for level gauges, vents, drains, overflow, access with safety cage ladders, landing & maintenance platforms, approach ladder for sight glass, handrails etc. as may be required. They shall be lined with suitable material capable of satisfactorily withstanding respective fluids to be handled by them.

All the tanks including chemical solution shall be provided with drain valves and piping, overflow piping and the same shall be led to a nearest drain sump. All the chemical tanks like AMT & CDT shall be provided with removable top covers in two halves and level indicators of suitable MOC of the respective medium handled, to indicate level.

Design of pressure vessels shall conform to IS 2825 and atmospheric tanks shall conform to IS-803. All the nozzles shall be provided with necessary valves for open / close for regeneration operation.

All the manhole doors shall be provided with davit arrangement.

All the vessels nozzles shall be fitted with leak proof dummy flanges along with gaskets before dispatch.
4.4.3 FRP Tanks / Pipe design considerations:

Tanks shall be vertical, cylindrical, (tapered bottom wherever needed) with level indication. The top cover shall be flanged type with suitable reinforcing and bracing.

Each tank shall have four support pads with bolt hole & PCD not more than 150 mm beyond the tank diameter.

Nozzles on top, sideways and bottom heads shall have a flanged faces perpendicular to the vertical centerline of the tank and nozzles on sidewalls shall have flanges faces perpendicular to radial centerlines. Tolerance on angle of flange face with respect to tank centerline is ½ degree. All the nozzles with flange shall be molded integrally with tanks.

The tank shall be continuous filament wound type and there shall be no long seam joint in the cylindrical shell. Filament would reinforced tanks shall be considered. The minimum total laminate thickness of the filament wound tank shall not be less than 10 mm all around and minimum 10 mm for tank flange and flanged top cover, tank bottom corners and all nozzle flanges without exception. UPVC/PP lining shall be provided for a min. thickness of 2 mm for alkali.

Each tank shall have inlet, outlet, drain, overflow, service water inlet, level indication nozzles etc. Drain & overflow lines shall be minimum one size higher than the pump discharge line size.

Each tank shall be equipped with a flanged level indicator / gauge. The gauge shall include two CPVC isolation ball valve, 20 mm dia glass tube and indicator board calibrated in cm.

Resin used for the tanks shall be of suitable grade, corrosion-resistant thermosetting, fully tested and accepted for the severe conditions. All internal surfaces, exposed to chemical, shall be resin rich and the thickness of this inner layer shall be minimum of 2 mm by vinyl ester resin. Isophthalic resin shall be used for rest of the thickness lamination. The glass content of inner layer shall be 25 to 30 % by weight. The glass content of filament wound structural layer shall be 55 to 70 % by weight. UPVC/PP lining shall be provided for a min. thickness of 2mm.

Suitable opening shall also be provided in these tanks to house agitator.

The guide lines stated above is also holds good for FRP pipe line with applicable pressure rating. (The glass content of inner layer shall be 25 to 30 % by weight. The glass content of filament wound structural layer shall be 55 to 70 % by weight).
4.4.4 CENTRIFUGAL PUMPS:

1. The critical speed of the pumps shall be well away from the operating speed and in no case less than 130% of the rated capacity.

2. The pumps shall have stable head Vs capacity characteristic continuous rising towards shut-off with an approximate shut-off head of 15% more than the design head for radial flow type pumps.

3. The characteristic curves of set of pumps shall match other for load sharing incase of parallel operation.

4. Pumps shall be provided with non-return valve & shut off valve on discharge side and shut-off valve on suction side.

5. The vibration level must be within the satisfactory zone as per ISO 10816-3:1998(E) for machine group 3 standard for rigid supported base with zone boundary B/C.

6. Tolerance on pump guaranteed efficiency and rated head for the rated flow shall be plus 3% to minus 2%.

7. Pressure gauges shall be provided on discharge side of all pumps individually.

8. Each pump suction and discharge shall be installed with an expansion bellow.

9. The pumps shall be designed for continuous operation at its best efficiency to satisfy the performance requirements.

10. The pumps shall be controlled from remote panel and locally.

4.4.5 DEMINERALISING SYSTEM:

The demineralising system shall comprise of equipments as listed in equipment specification. However, the design criteria shall be as mentioned below:

1. MB unit shall be rated for a normal flow rate to meet net output between regeneration. The flow rate shall be sized suitably to meet the guarantee requirement.

2. The air blowers shall be designed to supply the required quantity of oil free compressed air at required pressure for mixing the Anion and Cation resins after regeneration. The supply shall also include all necessary piping, valves, fittings, pressure gauges, suction silencer-cum-filter, belt guard, relief valve etc.
3. Necessary Resin traps, distributor, nozzles, manholes, inlet / outlet / regeneration nozzles, drain, vent, necessary sight glasses for viewing resin level, mounting legs, valves for automatic operation / regeneration of the system in the mixed bed units shall be supplied with all necessary piping, valves.

4. Resin selection criteria, calculation for arriving at resin quantities and the resin characteristic curves shall be submitted along with the offer.

5. Bidder to consider regeneration process shall be based on self-neutralization and also to furnish chemical calculations for regeneration of resins.

4.4.6 RESIN REGENERATION SYSTEM:

4.4.6.1 CATION & ANION REGENERATION:

1. The Cation exchange resins shall be regenerated with Hydrochloric acid of ~30% concentration as per IS 265 and the Anion exchange resins will be regenerated with Sodium Hydroxide solution of ~48% concentration as per IS 252 technical grade / rayon grade. These chemicals will be drawn from Bulk storage tanks (Bulk storage tanks are included in bidders scope). The required chemicals are excluded from bidders scope. The required pump, valves, pipelines etc. required for the transfer of chemicals will be in bidders scope and will be provided during ordering.

2. The bidder shall include the required regeneration equipments in their scope.

3. Acid measuring / dilution tank for the regeneration of cation resin shall be of sufficient capacity to store the quantity of acid required for atleast one regeneration with 25% margin. The tank shall be of MSRL with removable top covers with level indicators. Fume absorber shall be provided for this tank.

4. Alkali measuring / dilution tank for the regeneration of anion exchanger shall be of sufficient capacity to store the quantity of alkali required for atleast one regeneration with 25% margin. The tank shall be of FRP with UPVC / PP lining with removable top covers with level indicators to indicate the level. Suitable agitator shall be provided to dilute the NaOH solution from 48% to 30 %.

5. Separate hydraulic injector / ejector for anion and cation resins for diluting the alkali / acid to the required level and dosing it to respective resin shall be supplied.

6. Suitable density indicators and flow orifice board / plate shall be provided to determine the exact strength of the acid / alkali injected and flow rate to the exchanger. The flow indicator shall be of unbreakable type to withstand hydraulic hammer etc. and the make
7. The dilution ratio of the ejector shall be properly selected such that the bed can be effectively regenerated employing power water at the available pressure. The ejectors and nozzles shall be suitably designed for acid service and high velocity of liquid.

8. Safety showers with eye-wash meeting B.I.S specification shall be provided in the acid, alkali handling area (AMT & CDT area).

### 4.4.6.2 DRAIN NEUTRALISING SYSTEM:

1. Provision shall be made by the bidder to neutralize wastewater arising out of the regenerating chemicals. The arrangement shall be as follows:

   a. Wastewater from the resin bed shall be led into individual drain sumps near these vessels. Bidder shall provide measuring orifice boards with level marker into these sumps. Wastewater from sump shall be led into a gravity trench suitably lined and leading to neutralizing pit.

   b. Bidder should indicate the neutralizing chemical requirement to keep pH of the waste effluent generated, around **6.5 to 8.5**.

### 4.5.0 PIPING

#### 4.5.1 LINE SIZING

a. Sizes of pipelines shall be selected such that the velocity of fluid in pipes does not exceed the following limits under conditions of maximum possible volumetric flow:

   - **Pump Suction**: <1.2 m/sec
   - **Pump Delivery**: <2.5 m/sec
   - **Service water / Potable water**: 1.5 m/sec
   - **Compressed air**: 15 m/s

b. Lower values of velocities than those stated above shall be used to determine line size if dictated by considerations of pressure drop, NPSH, surges, water hammer, etc.

c. The design flows considered in line sizing shall not be less than the rated capacities of equipment to which the piping is connected such as pumps, blowers, compressors, valves, flow limiting orifices, etc., or, the system mass balance diagrams.
d. All high points in piping system shall be provided with vents along with valves. All low points shall be provided with drain along with drain valves.

e. Necessary moisture traps shall be provided in the compressor air line at strategic location.

f. Necessary supports for the considered pipelines are in the scope of bidder. The supporting arrangement shall be rigid and properly designed for the systems where hydraulic shocks and pressure surges may arise in the system during operation.

g. Sufficient upstream and downstream lengths shall be provided for flow measuring device, control valves and other specialties.

h. Bidder shall provide suitable sampling points with SS 316 valves to take water samples for testing purpose. The water samples shall be through 20 mm NB dia pipes of SS 316.

i. Test certificate / Compliance certificate to be furnished by the bidder for all the MSRL, SS, GRP/FRP piping and piping components etc.

### 4.5.2 MATERIAL OF CONSTRUCTION:

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>SERVICE</th>
<th>SIZE</th>
<th>PIPES</th>
<th>FITTINGS</th>
<th>FLANGES</th>
<th>GASKETS</th>
<th>LINE JOINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>MB FEED WATER</td>
<td>NB 65MM &amp; ABOVE</td>
<td>ASTM A53/ IS-1239-Heavy</td>
<td>ASTM A234 Gr. WPB</td>
<td>ASTM A105</td>
<td>NEOPRENE RUBBER / EPDM</td>
<td>FLANGED</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(RUBBER LINED 3 MM THK)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NB 50MM &amp; BELOW</td>
<td>ASTM A312 TP 316 seamless</td>
<td>ASTM A403 Gr.WP 316/A 182-F316</td>
<td>ASTM A105</td>
<td>NEOPRENE RUBBER / EPDM</td>
<td>SOCKET WELTED</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>DEMINERALISED WATER (MB OUTLET)</td>
<td>NB 65MM &amp; ABOVE</td>
<td>ASTM A312 TP 316L / CF8M</td>
<td>ASTM A403 Gr.WP 316/A 182-F316</td>
<td>ASTM A105</td>
<td>NEOPRENE RUBBER / EPDM</td>
<td>FLANGED</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NB 50MM &amp; BELOW</td>
<td>ASTM A312 TP 316 seamless</td>
<td>ASTM A403 Gr.WP 316/A 182-F316</td>
<td>ASTM A105</td>
<td>NEOPRENE RUBBER / EPDM</td>
<td>SOCKET WELTED</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>INSTRUMENT AIR SYSEM &amp; POTABLE WATER SYSTEM</td>
<td>NB 50MM &amp; BELOW</td>
<td>ASTM A53 GALVA-NISED / IS-1239-Heavy</td>
<td>ASTM A234 Gr. WPB GALVANISED</td>
<td>ASTM A105</td>
<td>NEOPRENE RUBBER / EPDM</td>
<td>SCREWED</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>CHEMICALS Like HCl, ALL SIZES</td>
<td>CPVC, schedule 80 of</td>
<td>CPVC, schedule 80 of</td>
<td>CPGF / PP /GRP /EPDM /Viton rubber</td>
<td></td>
<td></td>
<td>Flanged / insitu joint</td>
</tr>
</tbody>
</table>
Notes

1. The material of DM water system Piping from MB outlet to DM water storage tank shall be ASTM A 312 TP 316L. Thickness shall be to suit system requirement. However minimum schedule 10 thick pipes shall be used. Fittings shall be of SS 316L and corresponding pipe thickness.

2. Pipes shall be tested for its material composition and certificate shall be enclosed for the same. Each length of pipe shall be hydro-tested at shop as per the Codes/Standards.

3. Blind flanges on SS Pipe lines shall be to ASTM A 240-TP 316. Stub ends shall be used at flanged connections.

4. Cast steel valves shall be provided for compressed air system.

5. All branch connections shall be wrought or forged steel based on the size and availability based on ASTM Standards.

6. All piping from RO stage-2 permeate storage tank to mixed bed vessels outlet including frontal piping shall be trial assembled and tested before despatch.

7. All piping & valves supports shall be of dismantling type for easy maintenance using suitable bolted connections.

9. All non metallic piping shall be CPVC, industrial grade, Schedule 80, GF or Astral or FIP make including diaphragm valves, where ever called for. For more details refer cl. 4.5.2.

4.5.3 LAYOUT & DETAILING

1. A good engineering practice must be followed in manufacturing the piping weldments like edge preparation, slope, drain & vents by preparation of detailed layout drawing.
2. Overhead piping shall have a minimum vertical clearance of 2.3 metres above walkways and working areas and 7.5 metres above roadways unless otherwise approved by the BHEL-ENGINEER.

3. Provision shall be made while preparing piping layout to accept control valves, flow measurement element and any other on-line specialty or equipment. Sufficient upstream and downstream lengths shall be provided for flow measuring devices, control valves, and other specialties as required by the respective equipment manufacturer.

4. All the screwed valves and screwed connections on equipment shall be provided with unions to facilitate easy assembly / disassembly. Likewise, unions shall also be provided at suitable points on straight length of screwed pipelines.

5. The hangers and supports shall be spaced in accordance with standard engineering practice as outlined in applicable codes and standards.

4.5.4 DIMENSIONAL STANDARDS

1. Uniform dimensional standards for all piping components shall be employed to ensure compatibility with each other.

2. Nominal pipes sizes and pipe outside diameters shall generally be as per ANSI B 36.10.

4.5.5 WELDING AND HEAT TREATMENT

All heat treatment, welding, post and pre weld temperatures shall be as per the applicable ASME code.

4.5.6 INSPECTION & CLEANING

All pipes shall be thoroughly cleaned & hydro-tested at shops for pressures as per standards and all erected piping shall be cleaned & tested at 1.5 times the design pressure.

All hot bent, forge-formed, fabricated and straight pipes shall be chemically cleaned, pickled or wire brush cleaned and purged with air blast or shot/grit blast to remove all sand and scale from the inner surface as applicable during manufacturing.

The Contractor shall carryout the following cleaning after hydro-test.

a. All piping shall be mass flushed, in addition to the specific cleaning operations as described below, as required.

b. Compressed air piping shall be blown by air.
4.5.7 UNDERGROUND PROTECTION

Where pipelines are buried, underground protection shall be provided for the piping system by any one of the methods given below:

a. Coal tar primer, coal tar enamel, inner wrap of fiberglass, final outer wrap of enamel impregnated fiberglass. Total thickness of coating shall not be less than 4.0 mm.

b. With anti-corrosive tape of 4 mm thick conforming to IS-10221 and AWWA C 203-93.

4.6 VALVES

4.6.1 DESIGN AND CONSTRUCTION FEATURES

The following consideration shall be made during the design / selection of valves for the MB System.

1. For the MB system diaphragm type valves shall be used for isolation / regulation purpose.

2. Bidder to select suitable material of construction for the valves based on the system requirement and shall be clearly indicated in the offer.

3. The end connection for the valves shall be of flanged type as per ANSI B16.5 #150.

4. Pressure rating of valves shall be of minimum 150 psi.

5. Necessary pneumatic actuated valves shall be provided for auto operation(option for manual opening and closing also provided) & regeneration of the plant as per P&I D.

6. The check valves shall be of wafer type swing check valve suitable for mounting between flanges.

7. The Material of Construction of the body and disc of check valve shall be SS 316/CPVC.

8. Cast steel valve shall be provided for compressed air system.

9. Bidder shall furnish the valves schedule in the attached format. (Annexure-5)
4.6.2 VALVE - MATERIALS

<table>
<thead>
<tr>
<th>SL NO.</th>
<th>SERVICE</th>
<th>SIZE</th>
<th>BODY/ BONNET</th>
<th>DIAPHRAGM / DISC / BALL</th>
<th>STEM / SHAFT</th>
<th>HAND WHEEL</th>
<th>VALVE ENDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>DM WATER &amp; DG WATER</td>
<td>≥50NB</td>
<td>IS 210</td>
<td>EPDM</td>
<td>ASTM A47</td>
<td>FLANGED</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤50NB</td>
<td>FG 200</td>
<td></td>
<td>Gr 32510</td>
<td>#150PSI</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rubber lined</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DIA PHRAGM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>VALVE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>DM WATER &amp; DG WATER</td>
<td>≥50NB</td>
<td>IS 210</td>
<td>SS 316</td>
<td>ASTM A47</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pumps suction &amp; delivery</td>
<td></td>
<td>FG 200</td>
<td></td>
<td>Gr 32510</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rubber lined</td>
<td></td>
<td></td>
<td>FLANGED</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>BFV</td>
<td></td>
<td></td>
<td>#150PSI</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SOCKET WELDED</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ASTM A312</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TP 316</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>INSTRUMENT AIR SYSTEM</td>
<td>≤50NB</td>
<td>ASTM B 62/</td>
<td>ASTMB 62 /</td>
<td>ASTMB 62</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(BALL VALVES)</td>
<td></td>
<td>IS: 318 Gr 2</td>
<td>IS: 318 Gr2</td>
<td>Gr 32510</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SCREW TYPE</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4</td>
<td>CHEMICALS</td>
<td>ALL SIZE</td>
<td>CPVC</td>
<td>EPDM</td>
<td>POLYPROPYLENE</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ASTM D1784</td>
<td></td>
<td></td>
<td>FLANGED / SOCKET</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PN 16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE: 1  Testing of body and seat shall be as per ANSI B16.34
2.  For water system with sizes greater than NB200 butterfly valves shall be used and shall conform to AWWA C-504.
3.  Flange drilling shall be as per ANSI B16.5, #150 psi.

4.7 PAINTING

4.7.1 GENERAL
(a)  All the Equipment, steel structures and piping etc. shall be protected against external and internal (if any) corrosion by providing suitable painting as described below unless otherwise specified elsewhere. However, the surfaces of stainless steel, Galvanized steel, Gunmetal, brass, bronze, UPVC /CPVC pipes, HDPE pipes and non-metallic components shall not be applied with any painting.

(b) All painting shall be carried out in conformity with the paint manufacturer's recommendation.
(c) Codes and Standards:
Painting of equipment shall be carried out as per the specifications indicated below and shall confirm to the relevant IS specification for the material and workmanship.

The following applicable Indian Standards may be referred to carrying out the painting job:

- **IS : 5**: Colours for ready mixed paints and enamels
- **IS:1303**: Glossary of terms relating to paints.
- **IS:158**: Ready mixed paint, brushing, bituminous, black, Lead free, acid, alkali, water and heat resisting
- **IS:2074**: Ready mixed paint, air drying, red Oxide Zinc Chrome, priming
- **IS:104**: Ready mixed paint, brushing, Zinc Chrome, priming
- **IS: 2932**: Enamel, synthetic, exterior (a) undercoating (b) finishing

(d) No painting or filler shall be applied until all repairs, hydrostatic test and final shop inspection are completed.

(e) All paints, when applied in a normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks.

(f) Finish paint coating of DFT 50 microns at site shall be done after completion of erection & Commissioning.

### 4.7.2 PREPARATION OF SURFACES

All surfaces to be painted shall be thoroughly cleaned by sand /shot blasted to SA 2 1/2 finish as per Swedish standard SIS 055900 of all grease, oil, loose mill scale, dust, rust, slag and any other foreign matter. Mechanical cleaning by power tool and scrapping with steel wire brushes shall be adopted to clear the surfaces. However, in certain locations where power tool cleaning cannot be carried out, sand scrapping may be permitted with steel wire brushes and or abrasive paper. Cleaning with solvents shall be resorted to only in such areas where other methods specified above have not achieved the desired results. Cleaning with solvents shall be adopted only with the approval of the BHEL –Engineer.
4.7.3 PRIMER PAINT

One coat of Epoxy Zinc Phosphate primer shall be applied. After this first coat is dried up completely, second coat shall be applied. Primer shall be applied by brushing / spray to ensure a continuous film without ‘holidays’.

No. of coats: 2
The total dry film thickness shall be minimum 100 microns.

4.7.4 FINISH PAINT

First coat of Epoxy finish shall be applied. After this first coat dries up hard, the surface is wet scrubbed cutting down to smooth finish and ensuring that at no place the first coat is completely removed. After allowing the water to get evaporated completely, the second finish coat shall be applied.

No. of coats: 2
The total dry film thickness shall be minimum 100 microns.

(Above Painting procedure described is as per BHEL PRQA : 526 Rev. 01)

4.7.6 SUGGESTED COLOUR CODES FOR PAINTING

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>ITEM / SERVICE</th>
<th>COLOUR</th>
<th>IS-5 Grade</th>
<th>Colour (Band)</th>
<th>IS-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vessel &amp; all other proprietary equipment</td>
<td>Light gray</td>
<td>631</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Pumps and motors etc.</td>
<td>Light gray</td>
<td>631</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Tanks - indoor</td>
<td>Light gray</td>
<td>631</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Structures, platforms, ladders and handrails</td>
<td>Dark Admiralty Grey</td>
<td>632</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Control &amp; Relay panels</td>
<td>Light grey</td>
<td>631/7078 of IS1650</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Piping – DM water</td>
<td>Sea green</td>
<td>217</td>
<td>Light orange</td>
<td>557</td>
</tr>
<tr>
<td></td>
<td>Piping – Soft water, Potable &amp; filtered water</td>
<td>Sea green</td>
<td>217</td>
<td>French blue</td>
<td>166</td>
</tr>
<tr>
<td></td>
<td>Piping – Raw water</td>
<td>Sea green</td>
<td>217</td>
<td>White</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Piping – Air System (Station air &amp; Control air)</td>
<td>Sky blue</td>
<td>101</td>
<td>White for Control air</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

1. This colour code basically refers to IS:2379 for piping with necessary modifications
2. Where band colour is specified, same shall be provided at 5 meter intervals on long uninterrupted lines and also adjacent to valves and junctions.
4.8 VENDOR LIST FOR MECHANICAL ITEMS

Bidder to provide the vendor list for all major bought-out items along with the bid. However the following makes must be considered for items indicated as in the vendor list (4-WT-220-00098) enclosed with the specification.

5.0: ELECTRICAL, CONTROLS & INSTRUMENTATION

Electrical, control & Instrumentation requirements for the MB system is attached separately as ROS: 4053 Rev.00 along with this specification.

6.0: TECHNICAL DETAILS FOR CIVIL WORKS:

Construction of civil building, equipment foundation with pockets and flooring etc for the MB system is not in bidder scope. However the bidder shall provide the equipment layout drawing along with bid.

Detailed construction drawing with foundation requirement like load details, foundation pockets etc, for all the equipments & tanks, flooring requirements, protective coatings, trenches for pipe routing & drains, cable routing etc., shall be furnished to BHEL for further construction immediately after order.

Any special requirement like handling arrangement, floor / trench protection etc. shall also be indicated in the drawings. All the plant drains & trenches are to be connected in a common trench and terminated near MB Plant boundary.

Foundation bolts, nuts & washers for all equipments shall be supplied by the bidder as per their offered equipment requirement. The complete grouting material and grouting of equipment are in the scope of bidder.

The approximate area & location are indicated in the enclosed lay out drawing. Bidder to accommodate the MB system with in the stipulated area only as indicated in the typical layout drawing attached along with this specification.

7.0 : SYSTEM PERFORMANCE

The system performance guarantee and applicable penalty are detailed in this section.

7.1 PERFORMANCE GUARANTEE

7.1.1 The bidder shall guarantee all equipments for workmanship, materials and satisfactory performance. The guarantee for performance will cover individual items and systems including electrical for their ratings / outputs as well as for the integrated operation of equipment and its auxiliaries as a whole. On completion of satisfactory
commissioning, the supplier shall conduct performance / acceptance tests on the equipment and system as a whole for demonstrating the guaranteed performance parameters specified. All instruments, gauges installed for the normal operation of equipment shall, be made use of during the acceptance test as far as possible. If additional instruments are required for the tests, these shall be brought by supplier free of cost and shall be taken back after performance test. All the calibrations and the consumables, hardware etc. required for calibration are in bidder’s scope.

7.1.2 The Performance guarantee tests shall be conducted & cover the following but not be limited to the rated parameters for smooth operation of complete MB system:

a. Degasser outlet water quality as per annexure-1
b. MB system outlet Water quality as per annexure-1
c. MB system net output and gross output between regeneration as per Annexure -1
d. MB regeneration Chemical consumption including neutralizing chemical as per Annexure -1
e. Power consumption for continuous operating equipment as per Annexure-3
f. MB Regeneration time.
g. Guaranteed water consumption for each regeneration of MB.
h. Vibration and noise level of rotating equipment.

7.1.2 Minimum 3 performance test run shall be conducted between regenerations for the guaranteed value of treated water quantity and chemical consumption of which 2 consecutive test results shall meet the guaranteed values specified above (a to h)

7.2.0 General

In addition to the guarantees mentioned above, the requirements of specifications on all guarantees as elaborated under relevant clauses of Technical Specifications should be met.

The equipments supplied shall be guaranteed for a minimum period of 12 (twelve) months from the date of successful commissioning of the units is after PG test. (excluding Resins). **Resins guarantee shall be as per spec. clause no : 4.3.3-w.**

Any part which proves defective either in design, materials / and / or manufacture within the above guarantee period shall be replaced at free of cost to the owner at site and the provision of this clause shall apply to the portions of the plant so replaced or renewed until the expiration of the guarantee period or from the date of replacement which ever is later.
8.0 : SPARES

The bidder shall provide mandatory spares as per the list given below. The mandatory spares shall be delivered along with the main supply well in time before start-up & commissioning of the Plant. The mandatory spares list is indicated in this section. Over and above any additional requirements for trouble free commissioning of the equipment / system shall also be included in the list. Any unutilized mandatory spares shall be handed over to the Owner.

The price for the mandatory spares shall be provided separately along with the bid, this price will be included for bid evaluation.

Bidder shall decide the commissioning spares (if applicable) for trouble free commissioning of the plant and supply along with the main supply. The price for the commissioning spares shall be included in the main supply.

The commissioning spares for the E, C & I portion are indicated in the ROS 4054 vide Cl no. 2.8 in page no. 53 of 53 which are to be given compulsorily as commissioning spares.

8.1 MANDATORY SPARES

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description of the equipment</th>
<th>Description of spares</th>
<th>Qty</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Mixed Bed Feed pumps&lt;br&gt;Mixed Bed regeneration pumps</td>
<td>'O' rings and gaskets</td>
<td>1 set</td>
<td>For each type of pump</td>
</tr>
<tr>
<td>02</td>
<td>Mixed Bed Blower</td>
<td>V Belts&lt;br&gt;Filter elements&lt;br&gt;Seals</td>
<td>1 set&lt;br&gt;1 set&lt;br&gt;1 set</td>
<td>For each blower</td>
</tr>
<tr>
<td>03</td>
<td>Lubricants and grease (for initial fill)</td>
<td></td>
<td>1 lot</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Valves</td>
<td>Gland packing</td>
<td>01 set per valve for each size and type</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rubber Seal</td>
<td>01 set per valve for each size and type</td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>MB System</td>
<td>Distributer &amp; Nozzles</td>
<td>1 Set</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ejectors for Acid &amp; Alkali</td>
<td>1 set</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>Pressure Gauge</td>
<td></td>
<td>1 No.</td>
<td></td>
</tr>
<tr>
<td>07</td>
<td>Pressure switch</td>
<td></td>
<td>1 No.</td>
<td></td>
</tr>
<tr>
<td>08</td>
<td>Solenoid Coils</td>
<td></td>
<td>4 Nos.</td>
<td></td>
</tr>
</tbody>
</table>
9.0 : ERECTION , COMMISSIONING, PG TEST & HANDBLING OVER:

Erection, commissioning, trial operation, Performance Guarantee (PG) test and handing over of the MB system is attached separately as Part-2 along with this specification.

10.0 : DOCUMENTATION :

The documentation during bid and post order stage shall meet the following requirements.

1. All documents and drawings shall be submitted in English
2. Hard copies of all documents and drawings during bid stage to be submitted in duplicate.
3. Hard copies of all documents for approval shall be submitted in triplicate.
4. Hard copies of all final documents, drawings, erection and O&M manual etc., shall be submitted in bound folder in duplicate.
5. Soft copies of all final documents in MS word / MS office in the form of CD – 1 set
6. Soft copies of all final calculations in MS excel / MS officer in the form of CD – 1set
7. Soft copies of all final drawings in Auto Cad, latest version in the form of CD – 1set

10.1 : DOCUMENTS TO BE SUBMITTED ALONG WITH BID:

The following drawings / documents are to be enclosed along with the bid for scrutiny.

1. Complete confirmation to our specification by signing in each page with seal.
2. Duly filled up Data sheets enclosed - Annexure – 1 to 6
3. Technical write-up giving details of equipment, sequential operation, interlocks / control requirement.
4. Resin quantity calculations along with resin literature and characteristic curves.
5. Resin regeneration calculations.
6. Resin regeneration sequence with flow rate, duration, effluent details etc.,
7. Preliminary P& I diagram
8. Preliminary Equipment layout drawing
9. Typical internal arrangement drawing
10. Utility requirements like instrument air, service air and service water for regeneration and rinse etc.
11. Typical Quality Plan.
12. Pump performance curves with marked duty point.
13. Preliminary civil requirements.
14. PLC I/O list.
15. Details of Pneumatic Actuator
16. Un-priced commercial offer on the scope of supply
17. Un-priced commercial offer for the recommended spares list

Note:
1. In case of any deviation, the Bidder shall indicate the deviation, clause by clause in the deviation format attached in Annexure - 6. If there is no deviation “NIL” statement shall be furnished. In the absence of the non attachment of this Annexure-6, it will be construed that the bid confirms strictly to the specification. Acceptance or rejection of the offer with or without deviations (either fully or partially) is sole discretion of the purchaser without seeking further clarification from the bidder.

2. Bidder to note that failing to submit the above, the bid shall be considered as incomplete and offers are liable for rejection.

10.2 : DOCUMENTS TO BE SUBMITTED AFTER ORDER:

The following documents / Drawings and data to be furnished for BHEL / customer approval.

Phase – 1 with in 2 weeks from the date of purchase order receipt.

1. Foundation drawings indicating foundation design, load data, anchor bolt location, pocket details, floor & trenches etc.
2. Activity chart / Bar Chart and schedules for drawing submission, manufacturing, erection and commissioning
3. P and I Diagram including pipe sizes and terminal points.
4. Resin quantity calculations along with resin literature and characteristic curves.
5. Resin regeneration calculations and resin regeneration sequence with flow rate, duration, effluent details etc.,
6. Design calculation and thickness calculations for all major vessels and tanks as per code.
7. Generated regeneration water quantity / quality (TDS & pH and major constituents) of each regeneration
8. Duly filled Data sheets enclosed – Annexure 1 to 2
9. Equipment layout showing equipment details, headroom, size.
10. Technical Write-up and design basis
11. MB system “Control Description” write-up including sequential operation, controls, interlocks, protection, annunciation etc.
12. Quality Plan and field quality checks, stage inspection etc. for the above equipments & system
Phase – 2 with in 4 weeks from the date of purchase order receipt.

13. Detailed construction and cross-sectional drawings for the following:
   a. Vessel fabrication & assembly with Bill of material (BOM)
   b. Nozzle and Orientation
   c. Internals (Collector & distributors)
   d. Resin depth, filling details and preservation details
   e. Any other accessories with bill of materials.


15. Detailed assembly & cross sectional drawings with bill of material for blower, motor, V-belt, pulley, base frame, valves, silencers etc., with lifting arrangement for blower and motor.

16. Performance curves for pumps & blowers
   a. Flow Vs Head
   b. Flow Vs efficiency
   c. Flow Vs Power
   d. Flow Vs NPSH

17. Duly filled Data sheets enclosed – Annexure 3 to 5

18. Un-priced purchase order copies of the equipment & accessories ordered on sub-vendors (The list of approved sub-vendors are given in section ----)


21. PLC i/O list

Phase – 3 With in 8 weeks from the date of purchase order receipt for information.

22. Isometric drawing of pipe segments.

23. Erection Manual indicating
   a. Erection / installation instruction of equipments.
   b. Log sheet containing Stage check parameters & clearance
   c. Log sheet for Alignment Check of pump & motor
   d. Field quality checks

24. Performance Test procedure

25. As-built manufacturing drawing of the equipment and total system with bill of materials (BOM)

26. All the documents called in Electrical specification.

27. Detailed bill of materials for all the items with make / detailed vendor name etc.
10.3 : DOCUMENTS TO BE SUBMITTED BEFORE DESPATCH:

The following documents/Drawings are to be furnished for BHEL / customer review for information and before dispatch.

phase – 4

1. Pump & Blower performance test reports
2. Pump & blower performance guarantee certificates
3. Necessary material test certificates, hydraulic test certificates for all major items.
4. Operation and maintenance manual indicating, Operating procedure for start-up, normal operation, shut down and emergency shut down. Maintenance instruction & assembly
5. Lubrication chart
6. Electrical equipment layout, Cable trench layout, cable routing, cable schedules and cable termination details.
7. MB System Logic diagram & Sequential Flow Chart (SFC) for PLC
8. Cable interconnection diagram for cables up to junction box & cable schedule.
9. PLC I/O list.
10. Test Certificates for all the supplied instruments.
11. List of alarm, interlock & trip set points
12. Installation drawings for instruments
14. As built drawings
15. All other details called in electrical specification.

Note: Bidder to confirm in their offer that these details called in 13.1 & 13.2. will be provided.

11.0 : ATTACHMENTS:

1. Preliminary P & ID Drg No. : 1-WT-220-00253 Rev. 00 (with Terminal Points)
2. Typical layout Drawing No. : 1-WT-220-00254 Rev.00
3. Erection Specification (Part-2)
4. Specification for Electrical, Control & Instrumentation (ROS -4054 Rev. 00)
5. E,C & I BOQ : 3-WT-220-00232
6. Vendor List :4-WT-220-00098, Rev .00.
7. Instrument hook up drawings as per the ROS 4054, Rev.00.
ANNEXURE-1

GUARANTEE DATA SHEET

I  DEGASSER OUTLET WATER QUALITY

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Unit</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Carbon di Oxide as CO2</td>
<td>ppm</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Conductivity</td>
<td>µS/cm</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>pH</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

II  MIXED BED OUTLET WATER QUALITY

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Unit</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Conductivity</td>
<td>µS/cm</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SiO2 as SiO2</td>
<td>ppm</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Sodium as Na</td>
<td>ppm</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Total Hardness as CaCO3</td>
<td>ppm</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Organic matter as KMnO4 value</td>
<td>ppm</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Carbon Di Oxide</td>
<td>ppm</td>
<td></td>
</tr>
</tbody>
</table>

III  MB OUTPUT BETWEEN EACH REGENERATION

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Unit</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NET</td>
<td>Cu.M</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>GROSS</td>
<td>Cu.M</td>
<td></td>
</tr>
</tbody>
</table>

IV  CHEMICAL REQUIREMENT PER REGENERATION INCLUDING NEUTRALIZATION

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Unit</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HCl - 30%</td>
<td>kg/regen</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>NaOH - 48%</td>
<td>Kg/regen</td>
<td></td>
</tr>
</tbody>
</table>

V  MIXED BED RESIN (Anion & Cation)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Unit</th>
<th>Cation / Anion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Quantity per vessel</td>
<td>Ltrs</td>
<td>/</td>
</tr>
<tr>
<td>2</td>
<td>Life</td>
<td>Years</td>
<td>/</td>
</tr>
</tbody>
</table>
ANNEXURE –2

ELECTRICAL POWER CONSUMPTION

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Eqpt. Description</th>
<th>Qty</th>
<th>Drive rating KW</th>
<th>Conn Load KW</th>
<th>Power consumption KW**</th>
<th>Voltage, Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>FOR CONTINUOUS OPERATING EQPT.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>MB Feed Pump</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>DG BLOWER</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Sub total of A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>FOR INTERMITTENT OPERATING EQPTS.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>M.B Regeneration Pump</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Mixed Bed Blower</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CDT Agitator of MB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grand Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: 1. Power consumption for continuous operating equipment will be considered for bid evaluation and Guarantee purpose

W – Working       SB – Standby
BHEL Enquiry / P.O. Reference No. & Date:

ANNEXURE - 3

EQUIPMENT DATA SHEET

1.0 EQUIPMENT : DEGASSER TOWER & ACCE.

2.0 Application : To reduce CO2 level in the permeate water from R.O stage-1 Desalination Plant.

3.0 Quantity : TWO (2) set

4.0 Tower particulars
   a. Type :
   c. Make :
   d. Model :
   e. Flow rate in M3/hr - design/Max :
   f. Design Code :
   g. Corrosion allowance Shell mm :
   h. Material of Construction :
   i. Dia x Height mm :
   j. Thickness Shell/Ends mm :
   k. Surface Flow rate in m/sec-Design/Max:
   l. Velocity :
   m. Air to water ratio :
   n. Internal Protection :
   o. External protection :
   p. Design Pressure :
   q. Packing material of tower :
   r. Quantity of packing materials :
   s. Packing height :
   t. Inlet Nozzle size, type, rating :
   u. Outlet nozzle size, type, rating :
   v. Level switches :
   w. MOC of Rasching Ring :
6.0 **DEGASSER BLOWER**
   a. Qty. offered : 
   b. Capacity in m³/hr : 
   c. Head in mm WC : 
   d. Efficiency : 
   e. Make : 
   f. Type : 
   g. MOC of Blower - Casing : 
      Impeller : 
      Shaft : 
   h. Power rating of motor in KW : 
   i. Speed RPM : 
   j. Total weight of DGT assembly : 
   k. Noise level measured at 1 m distance : 

7.0 **MIXED BED UNIT**
   a. Quantity : 
   b. Type : 
   c. Net output, m³/hr : 
   d. Gross output between regeneration in M³ } : 
      excluding regeneration hrs. } 
   e. **Productive output between each regeneration** } : 
      excluding regeneration hrs. in M³ } 
   f. Operating cycle excluding regen.hrs : 
   g. Duration of regeneration hrs : 
      Regeneration type for Cation : 
      Regeneration type for Anion : 
   h. Material of Construction of Vessel : 
   i. Diameter -shell mm : 
   j. Thickness -shell & Dish Ends mm : 

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>k. Design Flow Velocity m3/hr/m2</td>
<td>:</td>
</tr>
<tr>
<td>l. Maximum velocity permitted m/s</td>
<td>:</td>
</tr>
<tr>
<td>m. Internal protection</td>
<td>:</td>
</tr>
<tr>
<td>n. Shore hardness</td>
<td>:</td>
</tr>
<tr>
<td>- Lining Material</td>
<td>:</td>
</tr>
<tr>
<td>o. External protection</td>
<td>:</td>
</tr>
<tr>
<td>p. Design Code</td>
<td>:</td>
</tr>
<tr>
<td>q. Corrosion allowance-Shell/DE mm</td>
<td>:</td>
</tr>
<tr>
<td>r. Thinning allowance-DE mm</td>
<td>:</td>
</tr>
<tr>
<td>s. Design Pressure</td>
<td>:</td>
</tr>
<tr>
<td>t. Test Pressure</td>
<td>:</td>
</tr>
<tr>
<td>u. Vessel dia x st. height x tot. ht mm</td>
<td>:</td>
</tr>
<tr>
<td>v. Resin bed ht. Anion/Cation mm</td>
<td>:</td>
</tr>
<tr>
<td>w. Free Board %</td>
<td>:</td>
</tr>
<tr>
<td>x. Nozzles size &amp; rating</td>
<td>:</td>
</tr>
<tr>
<td>y. No.of sight glasses &amp; size</td>
<td>:</td>
</tr>
<tr>
<td>z. No of manholes &amp; size</td>
<td>:</td>
</tr>
<tr>
<td>aa. Details about distributor nozzles</td>
<td>:</td>
</tr>
</tbody>
</table>
7.1 MIXED BED UNIT RESIN

a. Resin make & Model No. : CATION
b. Resin quantity, M3 : ANION
c. Resin Type :
d. Bed Depth, M :
e. Resin Life, years :
f. Ionic load as CaCO₃ mg/l :
g. Regeneration level, kg/m³ :
h. Operating Exchange Capacity:
   As CaCO₃, kg/m³ :
i. Derated Exchange Capacity, kg/m³ :
j. Qty of Acid 30% & NaOH 48% :
k. Time required / duration for Complete Regeneration :
l. Head loss through exchanger, m :
m. Resin Trap provided :
n. Attrition loss of resin per annum :
o. Quantity of DM water required per Regeneration with break up cycle :
p. Time required to complete one regeneration : Bidder to provide (max. 4 hrs)

7.2 MIXED BED BLOWER WITH MOTOR

a. Qty. offered :
b. Type & make :
c. Capacity M³/hr :
d. Head mWC :
e. Efficiency :
f. Power rating of Motor :
g. Coupling with Guard : 

h. Noise level : 

i. Blower speed : 

j. BHP KW : 

K. Material of Construction
   - Rotor 
   - shaft 
   - Gears
   - Main casing & side plates
   - Base frame

m. Lubrication

n. flow orientation

o. discharge line size

p. sealing

7.3 REGENERATION CHEMICAL : CATION | ANION

   a. Type & Specification :
   b. Chemical Concentration :
   c. Grade :
   d. Quantity required for each Regeneration on % basis :
   e. Protection from outside if any :

7.4 Measuring Tanks :
   1 Quantity :
   2 Type :
   3 Capacity Its :
   4 Dimensions ( dia x ht) :
   5 MOC :
   6. Thickness bottom, top circumference : 

Acid measuring Tank
Alakali measuring Tank
6 Internal protection, if any : 
7 Thickness of lining : 
8 Lining Material : 
9 Agitator quantity : 
10 Agitator M.O.C : 
11. Resin used for inner layer : 
12. Resin used for outer layer : 
13. The glass content of inner layer % by weight. : 
14. The glass content of filament wound } 
    structural layer % by weight { : 
16. Level Indicator make and details : 

8.0 DATA SHEET FOR MB FEED / MB REGENERATION CENTRIFUGAL PUMP

A. PUMP : MB FEED | MB REGEN.

I. TECHNICAL PARAMETERS 

a. Make : 

b. Model : 

c. Fluid details 
   - Medium handled : 
   - PH range : 
   - Specific Gravity : 
   - TDS/Chloride range ppm : 
   - Temperature range Deg.C : 

d. Design flow at rated speed cu.m/hr: 

e. Mini. & Max continuous flow M3/Hr : 

f. Total Head developed @design flow mWC : 

g. Shut-off head mWC : 

h. NPSH required (minimum) mWC : 

i. Design Pressure kg/cm2: 

j. Hydraulic test pressure kg/cm2: 

k. Pump efficiency at duty point % : 

l. Pump efficiency at maximum flow % : 

m. Pump shaft power reqd. at duty point  KW :

n. Maximum shaft power required  KW :

o. Selected Motor  KW :

p. Rated speed & Critical speed  rpm :

q. GD2 of the pump  kg-m2 :

r. Pump performance curve ref. Nos :

s. Upward / Downward thrust :

t. Operating flow range from duty point  % :

u. Noise level at duty range  dbA :

v. Vibration level
   - Displacement microns (peak to peak)mm:
   - Velocity (peak)  mm/sec:

w. Balancing quality as per ISO 1940 STD :

x. Rotation of shaft viewing from drive end :

y. Tolerance on guaranteed efficiency & head at rated flow and speed :

---

### II. CONSTRUCTION DETAILS

<table>
<thead>
<tr>
<th></th>
<th>MB FEED</th>
<th>MB REGEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Orientation</td>
<td>Horizontal</td>
<td>Horizontal</td>
</tr>
<tr>
<td>b. Suction / Discharge nozzle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Size</td>
<td>mm</td>
<td>/</td>
</tr>
<tr>
<td>- Rating</td>
<td>psi</td>
<td>/</td>
</tr>
<tr>
<td>- Flange drilling standard</td>
<td></td>
<td>/</td>
</tr>
<tr>
<td>- Nozzle Orientation looking from drive end</td>
<td></td>
<td>/</td>
</tr>
<tr>
<td>- Material</td>
<td></td>
<td>/</td>
</tr>
<tr>
<td>c. Material of Construction / Make</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Pump Casing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Impeller</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
- Shaft
- Shaft Sleeve
- Wear rings
- Diffuser
- Mechanical Seal
- Bearing housing
- Fasteners
- Others if any

d. No. of stages

e. Impeller type
f. Impeller diameter Trimmed / Untrimmed

g. BEARINGS
   - Type
   - Make
   - Lubrication oil spec.
   - Lubrication oil qty / pump

h. Mechanical seal
   - Type
   - Make
   - Model
   - Drawing No.
i. Pump dimension L x W x H
j. Pump Weight

III. COUPLING
a. Type
b. Make & Model No.
c. Coupling guard material
d. Dimension detail with BOM enclosed
e. Weight
IV. BASE FRAME AND ACCESSORIES
a. Material : 

b. Dimension detail mm : 

c. Weight kg : 

d. Foundation Bolt - Size & Qty mm & Nos. :
   - MOC :

V. GENERAL
a. Shipping package dimension mm :

b. Total Assembly / Shipment weight kg :

c. List of Special tools :

d. Accessories details :
## VALVES SCHEDULE - DATA SHEET

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Application</th>
<th>Type</th>
<th>Size</th>
<th>Pr. Rating Bar</th>
<th>Qty.</th>
<th>MOC of wetted Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Body</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Disc / Diaphragm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Stem/shaft</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lining</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ACTUATOR DETAILS</td>
</tr>
</tbody>
</table>

### MANUAL VALVES

I. MANUAL VALVES

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Application</th>
<th>Type</th>
<th>Size</th>
<th>Pr. Rating Bar</th>
<th>Qty.</th>
<th>MOC of wetted Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Body</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Disc / Diaphragm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Stem/shaft</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lining</td>
</tr>
</tbody>
</table>

### PNEUMATIC VALVES

II. PNEUMATIC VALVES

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Application</th>
<th>Type</th>
<th>Size</th>
<th>Pr. Rating Bar</th>
<th>Qty.</th>
<th>MOC of wetted Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Body</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Disc / Diaphragm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Stem/shaft</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lining</td>
</tr>
</tbody>
</table>

Page 54 of 55
## TECHNICAL DEVIATIONS

### ANNEXURE - 5

|--------|-------------|------------|------------|---------------|------------------------------------|----------------------|-------------------|
PART-2

ERECTION, COMMISSIONING, PG TEST, O&M FOR THREE MONTHS AND HANDING OVER
1.0 **SCOPE OF SERVICES**

The scope of Erection and Commissioning of systems {De-Gasser System and Mixed Bed (MB) System} comprises of collection of materials and equipment from site stores, transportation to erection spot, erection of complete system including site fabrication if any, stage clearance, testing, commissioning and PG (Performance Guarantee) Test. Further, O&M for three months after PG Test based on BHEL notification and handling over of these systems. Please refer the Note to Clause No. 1.0 Scope of Supply and Services in the main specification (Page No. 4 of 55).

The equipment after inspection at manufacturer’s works shall be transported to BHEL site and shall be delivered to the BHEL stores as in supply specification. Unloading of the materials at Site stores & storing of the materials is in BHEL’s scope. The applicable materials shall be drawn from BHEL stores as per the relevant procedure. The equipment shall be erected sequentially and shall be interconnected with the applicable piping and valve system. Necessary Hydro testing of piping shall also be carried out. All the dummy flanges etc. required for it are under the scope of bidder.

1.1 **The following are the scope of major equipment for the erection & commissioning of the mixed bed system at site.**

a. 1 x 100% MSRL Degasser tower with all internals & accessories
b. 1 x 100% MSRL Degassed Water Storage Tank (20 m³).
c. 2 x100% (1W + 1S) of Degasser Blowers with motors, Air filter box (suction) & accessories, interconnecting piping / ducts and valves from blowers to degasser tower.
d. 1 x 100% (1W) MB Unit along with all accessories, internals,
e. 1 set of Cat ion & anion resin for MB system
f. 2 x 100 % (1W+1S) Mixed Bed (MB) feed pumps with motors and all accessories.
g. 2 x 100% (1W+1S) MB regeneration Pumps with motors and all accessories
h. 2 x 100% (1W+1S) MB Blowers with motors and all accessories for MB regeneration
i. 1 x 100% Acid Measuring Tank (AMT), ejector & acc. etc for MB regeneration
j. 2 x 100% (1W+1S) Caustic Dilution Tank (CDT) with agitators, ejector & acc. etc. for MB regeneration.
k. 1 x 10m³ Bulk Acid Storage Tank (MSRL) with 2 x 100% acid unloading pumps with motors along with interconnecting piping & accessories.
l. 1 x 10m³ Bulk Caustic Storage Tank with 2 x 100% caustic unloading pumps with motors along with interconnecting piping & accessories.
m. 1 set of MB frontal piping & valves along with pneumatic operated diaphragm actuator.

n. 1 set of interconnecting piping system including valves and accessories etc. for the following areas:
   - Degasser system to MB feed pumps
   - Degasser blowers to degasser
   - MB feed pumps to MB vessel
   - MB blowers to MB vessel
   - MB regeneration pumps suction piping from DM Water storage tank upto pumps
   - MB regeneration pumps discharge to MB system, AMT & CDTs
   - Piping for bulk chemical storage system(unloading pump to tanks & from tanks to AMT/CDT)
   - AMT/CDT area to MB system.
   - MB outlet piping from vessel to outside of RO-DM plant building.

o. 1 set of necessary foundation bolts with fasteners for all the equipments.

p. 1 set of Electrical, Controls & Instrumentation as per specification & PID & ROS 4054.

q. 1 set of miscellaneous items including fasteners, gaskets, ladders, MB platforms, supports for piping and valves.

r. 1 set of Mandatory spares.

s. 1 set of Erection & Commissioning, trial operation and PG Test

t. O&M for three months after PG Test or based on BHEL notification

u. One set of O/M tools.

The above quantity and the details given are only indicative. However the bidder shall supply required quantity and carry out the erection of all the items to meet the system requirement as complete without any commercial implication to BHEL.

2.0 The Intent of this specification is to provide erection, commissioning, trial run, PG Test, O&M for three months and handing over of MB system for execution of projects according to most modern and proven techniques and codes. It is not the intent to specify completely herein, all aspects of the entire system. Nevertheless, the entire system shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation. The contract services towards installation of the Plant shall not relieve the contractor of the responsibility of providing such services, facilities to complete the project of portion of project awarded to him. The quoted rate shall deem to be inclusive of all such contingencies.
3.0 The Contractor shall carry out the work in accordance with instructions/ drawings/ specification/ standard practices supplied / approved by BHEL from time to time.

4.0 Modification / Rectification / repair / replacement of defective components if any shall be under bidder's scope within specified time without any commercial implication to BHEL.

5.0 Bidder to submit the erection schedule along with stage check data sheets. Each and every stage the bidder to get clearance from the BHEL Engineer / Customer Engineer.

6.0 Bidder to establish the site co-ordination for identification of materials, withdrawal of material from Site BHEL stores, taking delivery, co-ordination for the movement from store to erection work stage clearance for erection & commissioning.

7.0 All the equipments and materials would be issued only at BHEL stores and it shall be the responsibility of the contractor to take delivery from BHEL stores and transport the same to site

8.0 Bidder has to keep all equipments/materials under their safe custody till the completion of erection, commissioning, trial run and handing over of the System to BHEL. Bidder should ensure deployment of adequate security personal. Necessary security arrangement around the clock is under the scope of the bidder. If any theft, pilferage or any damages are to be replaced by the bidder at their expenses (without financial implication to BHEL).

9.0 Necessary clearance for stage check, hydraulic test, leak check from the customer engineer & pre – commissioning tests shall be carried out by the bidder.

10.0 Commissioning and putting into satisfactory operation of all the equipment at site including successful completion of trial run, PG Test and handing over of the system to the end user are the responsibility of the bidder.

11.0 Bidder shall arrange to carry out the repair paint and Finish coat (final coat) of painting of DFT as per the spec. for all of the equipment before hand over of the system to BHEL/Customer. This is required to cover up the possible damage for the external surface of all equipment during erection/handling.

12.0 O& M for 3 months after PG Test (Required man power, normal consumables, tools and tackles, instruments, etc., will be under the scope of the vendor. However, necessary chemicals as per the requirement details furnished by the vendor in their bid will be provided by BHEL, free of charge).
13.0 EXCLUSIONS

The following are excluded from the scope of supplier and will be arranged by BHEL

13.1 All civil works pertaining to DM Plant are excluded from the scope of the bidder.

13.2 Service water at one point near RO-DM Plant will be provided by BHEL on free of charge. Subsequent piping within and outside the plant are under the scope of the bidder.

13.3 Electricity (3 phase) will be available to the bidder at one point near RO-DM Plant on free of charge for erection purpose.

13.4 Service / instrument air will be made available at one point to the bidder on free of charge within the plant boundary. Subsequent piping within and outside the plant are under the scope of the bidder.

13.5 Chemicals for commissioning and trial operation of the plant will be supplied by BHEL.

13.6 Storage of shipped items / container at BHEL store as of received condition will be taken care by BHEL.

14.0 Specification, Standards & Codes:

All equipment shall be designed, tested and supplied as per the specification, relevant national / international standards & statutory codes.

15.0 Name plates, labels and directional marks:

Each equipment shall be provided with nameplate details designating the tag no., service of the item etc. Necessary directional arrow marks shall be provided. Equipment name shall be painted legibly with minimum 150mm size for the vessels.
16.0 Tools and Tackles:

All the Tools & tackles required for the complete erection of components shall be arranged by the contractor at his cost. The bidder shall have & own a complete set of special tools and tackles required erection, assembly, disassembly, maintenance and testing. The bidder shall also supply any special tools and tackles that may be required additionally during commissioning. All tools & tackles shall be reputed make with validity test certificates. One set of operation & maintenance tools for O&M for the system has to be supplied during the erection & commissioning and it will be retained by BHEL.

17.0 Commissioning Spares:

The bidder shall supply all consumables like lubricating oil, Teflon tape, m-seal, cotton waste, tissue paper roll, sampling bottles, mugs, buckets etc required for commissioning the equipment shall be in bidder’s scope.

The bidder shall consider sufficient quantity of the commissioning spares so that the commissioning of the system will not be delayed. The bidder shall also supply any spare components that may be required additionally during commissioning. These commissioning spares shall be included in the basic scope of supply.

18.0 Inspection & Testing:

All the stage checks & materials for erection shall be offered as per the Quality plan wherever applicable to BHEL / Customer for inspection. During erection, the internal inspection reports shall be submitted to BHEL / customer for information.

19.0 Additional requirements

19.1 After completion of all erection and commissioning works, the left out items shall be handed over to BHEL site stores.

19.2 During commissioning at site some smaller equipment may get added or Logics may have to be changed. The bidder shall carryout these changes at site without any commercial implications to BHEL.
20.0 GENERAL INSTRUCTIONS TO THE BIDDER

20.1 Bidder shall quote for complete work specified in the document. Incomplete quotations for the part of the work will not be considered even if the quoted rates/price is lower.

20.2 Bidder shall contact BHEL and obtain additional details/data if any required to submit proper quotation.

20.3 The Bidder shall include all necessary commissioning spares in his basic scope of supply.

20.4 Adequate lighting facilities such as low volt hand lamps shall be arranged by the contractor at the site of construction etc. at his cost.

20.5 All the lifting tackles including wire ropes, slings, shackles and electrically operated equipment shall be got test certificate & statutory authority approved before they are actually put on use. Test certificates & statutory authority approved certificate should be submitted to BHEL before their usage.

20.6 All equipment so used by contractor shall be of proven quality and safe in operation as approved by BHEL site Engineers from time to time.

20.7 At periodic / intervals of work, complete and detailed account of the equipment so for erected shall be submitted to the BHEL Engineer.

20.8 All equipments shall be handled very carefully to prevent any damage and loss. No bare wire ropes, slings etc., shall be used for unloading and / or handling for equipments. The equipments from the storage yard shall be moved to the actual site of erection / location at the appropriate time as per the direction of BHEL Engineer so as to avoid damage for such equipments at site.

20.9 The work covered under this scope of work is of highly sophisticated nature requiring best quality / precision workmanship engineering and construction management. He should also ensure successful and timely commercial operation of equipment installed. The contractor must have adequate quantity of precision tools, construction aids in possession. Contractor must also have adequate trained qualified and experienced supervisory staff and skilled personnel.

20.10 All the necessary certificates & licenses and statutory clearance required to carry out his scope of work are to be arranged by the contractor then and there at no extra cost.

20.11 When the work is temporarily suspended he shall protect all construction materials equipments and facilities from causing damage to existing property.
interfering with the operations of the station when it goes into services. The contractor shall comply with all applicable provisions of the safety regulations clean – up programme and other precautionary measures which the BHEL has in effect at the site.

20.12 It will be the responsibility of the contractor to ensure the safe lifting of the equipment taking due precautions to avoid any accidents and damage to other equipments and personnel.

All piping shall be adequately supported and protected to prevent damage during handling and erection.

20.13 Sometimes it may become necessary for the contractor to handle certain un-required components in order to take out the required materials. The contractor has to take this contingency also into account. No extra payment is payable for such contingencies.

20.14 Due to atmospheric conditions erected materials are likely to get rusted more frequently. It is the responsibility of the contractor to preserve the erection materials drawn from stores for erection till these are commissioned and handed over to customer. The required paint, thinner all other consumables like painting brush, emery paper, cotton waste, cloth etc., have to be arranged by the contractor at his cost. The quoted rates shall be inclusive of above work. The contractor should ensure that the materials are not rusted on any account till they are handed over to customer.

21.0 SITE CLEANLINESS AND SAFETY REQUIREMENTS:

21.1 Contractor shall strictly follow all safety regulations / conditions as per general conditions of contract.

21.2 Providing of safety equipments like Helmet, safety goggle, hand glows etc. under the scope of bidder. Non – conformity of safety rules and safety appliances will be viewed seriously and the BHEL has right to impose fines on the contractor as under.

21.3 Contractors shall ensure that the quality is maintained in all the works connected with this contract at all stages of the requirement of BHEL.
21.4 Contractor shall ensure that all Inspection, Measuring and Testing equipment that are used, whether owned by the contractor or used on loan, are calibrated by the authorized agencies and the valid calibration certificate will be available with them for verification by BHEL. A list of such instruments possessed by contractor at site with its calibration status is to be submitted to BHEL Engineer for control.

21.5 Contractors shall arrange for the inspection of the works at various stages as required by BHEL. Immediate corrective action shall be taken by the contractor for the non-conformances if any, observed and pointed out by BHEL.

22.0 All payments due to the contractor shall be made only through “e-Payment”. The Bidder has to furnish details of his Bank account as certified by the concerned Banker in the format attached to enable e-payment.

Applicable payment shall be made after the certification of completion by the site BHEL Engineer.

23.0 PROVIDENT FUND & MINIMUM WAGES

23.1 The contractor is required to extend the benefit of provident fund to the labour employed by them in connection with this contract as per the Employees Provident Fund Act 1952. For due implementation of the same, the bidder is hereby required to get themselves registered with the Provident Fund authorities for the purpose of reconciliation of PF dues and furnish us the code number allotted to them by the Provident Fund authorities with in one month from the date of issue of this letter of intent. In case any exemption from such remittance, an attested copy of authority for such exemption is to be furnished. Please note that in the event of failure to comply with the provisions of said Act, if recoveries there fore are enforced from payments due to BHEL by the customer or paid to statutory authorities by BHEL, such amount will be recovered from payments due to the contractor. Success full bidder before execution of work has to submit PF Regn. No. Labour License No. & Workmen Insurance Policy No.

23.2 The contractor shall ensure the payment of minimum labour wages to the workmen under him as per the rules applicable from time to time in the state.
24.0 OTHER STATUATORY REQUIREMENTS:

24.1 The contractor shall submit a copy of labour licence obtained from the licencing Officer (Form VI) u/r 25 read with u/s 12 of contract labour ( R&A) Act 1970 & rules and valid WC Insurance copy or ESI Code ( if applicable) and PF code no along with the bill.

24.2 The contractor shall submit bills along with the copies of monthly wages (of the preceding month) u/r 78 (1) (a) (1) of contract labour rules, copies of monthly return of PF contribution with remittance challans under EPF Act 1952 and copy of renewed WC insurance policy or copies of monthly return of ESI contribution with challans under ESI Act 1948 (if applicable) in respect of the workmen engaged by them.

24.3 The contractor should ensure compliance of Sec 21 of Contract Labour (R&A) act 1970 regarding responsibility of payment of wages. In case of “Non compliance of sec21 or non-payment of wages” to the workmen before the expiry of wage period by the contractor, BHEL will reserve its right to pay the workmen under the orders of appropriate authority at the risk and cost of the contractor.

25.0 TIME OF COMPLETION

25.1 The time schedule as prescribed in the contract is the essence of the contract. The time for completion shall always be reckoned from the date of commencement of work as certified by the BHEL Engineers.

25.2 The entire work shall be completed by the contractor with in the time schedule or within the such extended time as may be allowed under relevant clause.

26.0 ENGAGEMENT OF LABOUR

26.1 The contractor will be directly responsible for provision of health and sanitary arrangements more particularly described in contract labour (regulations & Abolition) Act, safety precautions etc., as may be required for safe and satisfactory execution of the contract.

26.2 The contractor shall be responsible for proper accommodation including adequate medical facilities & transportation to the work spot and back for the personnel employed by him.
27.0 COMPLIANCES WITH LABOUR LAWS & RULES

27.1 The contractor shall comply with all state and central Laws, statutory rules, regulations etc., relating to labour in respect of following acts and also as amended by the Government during the tenure of the contract and having in force or jurisdiction at site.

a. Payment of wages act, 1936
b. Minimum wages act, 1948
c. Workmen’s Compensation act, 1923
d. Industrial dispute act, 1947
e. Employees Provident fund scheme, 1952
f. Payment of Bonus act, 1965
g. Payment of Gratuity act, 1972
h. Contract Labour (Regulation & Abollition) Act, 1970

28.0 TAXES & DUTIES:

The contractor shall pay all taxes, VT, licence fee, deposits, duties, royalty, commissions or other charges, other than such taxes specifically mentioned in the special conditions of contract, which may be leviable on account of any of his operations in executing the contract. In case BHEL is forced to pay any of such taxes, BHEL shall have the right to recover the same from the contractor either from his bills or otherwise as deemed fit.
TECHNICAL SPECIFICATION

FOR

MIXED BED SYSTEM

ELECTRICALS, CONTROL & INSTRUMENTATION PORTION

<table>
<thead>
<tr>
<th>Rev.No</th>
<th>Date</th>
<th>Prepared</th>
<th>Checked</th>
<th>Approved</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>13.07.13</td>
<td>RPS/MKV</td>
<td>DNB</td>
<td>SK</td>
<td>Fresh issue</td>
</tr>
</tbody>
</table>
THIS DOCUMENT CONSISTS OF THE FOLLOWING SPECIFICATIONS:

1.0) GENERAL SPECIFICATION FOR E, C&I 03

1.1) E, C&I SCOPE OF WORK (ANNEXURE – ECI -1) 08

1.2) E, C&I SCOPE OF SUPPLY (ANNEXURE – ECI -2) 09

1.3) E, C&I SCOPE OF WORK BETWEEN BHEL & BIDDER (ANNEXURE – ECI -3) 10

1.4) LIST OF DRAWINGS / DOCUMENTS TO BE SUBMITTED ALONG WITH OFFER 11

1.5) LIST OF DRAWINGS / DOCUMENTS TO BE SUBMITTED AFTER ORDERING 11

2.0) E, C&I SPECIFICATION 13

2.1) SPECIFICATION FOR LT MOTORS (ANNEXURE – ECI -4) 13

2.2) SPECIFICATION FOR INSTRUMENTATION CABLES (ANNEXURE – ECI -5) 22

2.3) SPECIFICATION FOR FIELD MOUNTED JUNCTION BOXES & SOLENOID VALVE ENCLOSURE BOXES (ANNEXURE – ECI -6) 29

2.4) GENERAL REQUIREMENTS (ANNEXURE – ECI -7) 34

2.5) MEASURING INSTRUMENTS (ANNEXURE – ECI -8) 36

2.6) ACTUATORS & ACCESSORIES (ANNEXURE – ECI -9) 48

2.7) IMPULSE PIPING, TUBING, FITTINGS, VALVES & VALVE MANIFOLDS (ANNEXURE – ECI -10) 50

2.8) COMMISSIONING SPARES (ANNEXURE – ECI -11) 53
1.0 GENERAL SPECIFICATION FOR ELECTRICAL, CONTROLS & INSTRUMENTATION:

1) ELECTRICAL, CONTROL & INSTRUMENTATION (E,C&I) scope of work by System bidder, scope of work between BHEL & BIDDER, Scope of supply for the system between BHEL and Bidder shall be as per ANNEXURE–ECI-1, ECI-2 & ECI-3 to this specification.

2) The bidder shall provide all necessary inputs to enable the Customer (BHEL) to design & procure the LT MCC, for the system.

3) All E,C&I equipment shall be suitable for the power supplies, fault levels and other climatic conditions indicated in “Project Information” mentioned elsewhere in this enquiry.

4) The system bidder shall provide necessary Electrical, Control & Instrumentation equipments, Pneumatic Operated Valves (POVs), Control Valve etc. in this plant to facilitate auto operation.

5) The system bidder should furnish a "Write up on Control Description" explaining the controls, interlocks etc., for the auto operation of the system for information/review. Necessary Sequence Flow Charts, Logic Diagram etc., have to be furnished during detailed engineering to facilitate implementation of the system controls & interlocks in the PLC/DCS system.

6) Based on the inputs, the PLC/DCS Vendor will prepare the engineering software in the form of ladder diagrams for the system. The system bidder shall review and approve the ladder diagram for implementation. Once the system requirements are implemented in the PLC/DCS system after bidder’s review & approval, the responsibility for proper functioning of the entire system in Auto & Manual mode shall rest with the bidder.

7) All field initiating devices like Pressure / Temperature / Flow / Level switches shall have the terminal block inside the switch enclosure to which external cables shall be wired. The terminals shall be suitable for 2.5 sq mm copper stranded conductor. Necessary plug in socket shall also be provided for electrical connection. The terminals of the field initiating devices shall be wired to junction boxes by cables with necessary cable trays & supports by bidder.

8) Junction Boxes being supplied by bidder shall comply with junction box requirements given in ANNEXURE-ECI -6.

9) Analytical instruments for pH / ORP / Conductivity / Silica / Turbidity etc. shall consist of sensor & microprocessor based analyser which shall be located in
the field. Only 4 - 20mA Single / Dual output signals from the analysers shall be brought to the PLC/DCS system where these parameters will be displayed on the PC screens using HMI software. Necessary calibration solutions / buffer powders / reagents etc. required for calibration & commissioning of analytical instruments shall be included by the bidder in his scope. The offer should include rates for such calibration solution / buffer powder / reagents and the periodicity and quantity requirement.

10) To facilitate Auto operation of the system, valve operation shall be pneumatically operated. Accordingly bidder to indicate the Instrument air requirement taking into consideration the maximum number of pneumatic valves that can operate simultaneously at any point of time.

11) Tanks shall be provided with float operated level indicators, level gauges, level transmitters and level switches, as required, with complete assembly. Suitable flanged pads for level switch mounting shall also be provided. The level indicator can be top or side mounted as the case may be.

12) All drive motors for the plant shall be supplied as per Annexure ECI-5 and Motor Data sheet enclosed. The complete data for all motors shall be furnished in the Data sheet format enclosed to motor specification, during detailed engineering.

13) Cable glands shall be of tinned brass (double compression type) conforming to BS 6121. Cable lugs shall be of heavy duty, crimping type, tinned copper / Aluminium conforming to IS.

14) Make of various equipments / items in the scope of bidder shall be as per Vendor list enclosed with the enquiry. The bidder must indicate make of various equipments clearly in the offer. The words equivalent / reputed make are not acceptable.

15) Bidder shall furnish Electrical Power Consumption for various drives in the format enclosed, along with the offer to enable the customer to design the MCC for feeding the System loads. Based on this input, starters & controls will be provided by BHEL in the UF-RO-MB Plant LT MCC. Once the system requirements are implemented in the LT MCC system, the responsibility for proper functioning of the entire system in Auto & Manual mode shall rest with the bidder.

16) Bidder shall furnish schedule of Analytical Instrument Power, control & screened cables, Indicating Quantity of cables required, within 2(two) weeks after award of contract. However, bidder shall furnish tentative quantity of power, control & screened control cables with the offer also.()

17) Any equipment, fitting and instrument though not specifically mentioned in the specification, PID and BOQ, but considered essential, necessary for the
efficient and safe operation of the system shall be included in this supply by the bidder. All instruments shall be calibrated in metric units.

18) The detailed specification of various electrical / control equipments and supply system are given in the respective sections of this specification.

19) The instruments offered shall be of reputed make and shall have accuracy and Tolerances suitable for the purpose. Complete bill of material for control & instrumentation indicating make, type, range, quantity and location, number of signalling contacts, their rating, shall be provided by the bidder and any item of equipment instrument even though not included in bill of material but required as per scheme or otherwise for the completion and efficient functioning of the system shall be deemed to be included in the bill of material at no extra cost. The bidder shall provide detailed schematics for the controls and protections along with flow diagram clearly indicating all local control panel instruments. The instruments shall be of approved make as per the approval of Customer.

20) The instruments offered shall be complete with all accessories like isolating valves, automatic temperature compensation, monitoring accessories etc.. All instruments shall have a degree of protection as given in detailed technical specification.

21) Instruments / relay contacts shall conform to the relevant C&I sections of this Specification and shall be adequately rated to suit interlock / alarm circuitry requirements.

22) All auto valves shall be pneumatic operated type. Limit switches shall be provided on all the auto valves. Facility for adjusting speed of opening / closing of the valve shall be provided for each valve to prevent system upsets by quick opening / closing. Bidder shall furnish complete details of pneumatic actuator along with the offer.

23) All instruments shall be subjected to Routine & Type test as per relevant applicable latest standards. If Type tests are performed already on identical model, valid type test certificates are acceptable. Necessary Routine & Type test certificates shall be furnished by the bidder for all instruments.

24) We have enclosed a set of typical drawings for the frame works (for installation of instruments). Bidder may choose GI steel pipes for the fabrication of the frame instead of angles & channels wherever required. **Necessary SS fasteners and U Clamps are to be provided by the bidder for fixing the instruments.**

25) Bidder shall submit the detailed installation drawing for each instrument, showing the various components such as connector, SS tubing, valves, 2 / 3 / 5 valve manifolds etc. for the approval of BHEL. This is to ensure proper erection at site.
24) **Junction Boxes / Field Termination Cabinets shall be provided for**

   (a) Termination of all sensors and transmitters located area wise
   (b) Termination of transmitters to JB which is mounted on the transmitter racks.
   (c) Termination of both the contacts of switches and duplex elements of Temperature measurement.

   The arrangement of terminals in the field junction boxes and the system cabinets in the control room shall match 1:1 to avoid any field marshalling issues.

25) **INSTRUMENTATION & CONTROL CABLES:**

   These shall be supplied to:

   Connect field instruments to Field Junction Boxes/ Field Termination Cabinets.

   Connect limit switches, torque switches and position transmitters to Field Junction Boxes / Solenoid valve Boxes.

26) **Pneumatic Operated Valve / Control Valve :**

   26.1 **Pneumatic Actuators shall be used for operating actuated valves, wherever required.** All pneumatic actuators included in the scope of bidder for ON/OFF and regulating services shall be complete with all accessories including the following:

   **Valve Actuators Accessories**
   All pneumatic actuators (for valves) included in the scope of BIDDER for ON/OFF and regulating services shall be complete with all accessories including the following:

   26.2 **Air Filters Regulators shall be provided in the following:**

   Air supply line to valve positioners
   Air supply line to Electro pneumatic converters
   Air supply line to each Solenoid Valve Box

27) **Additional requirements**

   a) All mounting accessories for various instruments shall be supplied as a part of basic scope of this package.
   b) Erection hardware like root valves, impulse lines, 2 / 3 / 5 valve Manifolds shall also be supplied as a part of basic scope of this package.
   c) Electrical equipments and instruments shall be provided with suitable earthing terminals as per relevant IS standard.
   d) Instrument air will be made available at one point. Further distribution shall be taken care of by System bidder.
   e) KKS tag numbering philosophy would be uniform for the entire plant. There would be a single, unique tag for a given equipment / signal.
f) After completion of all erection and commissioning works, the left out items/ spares / tools & tackles / calibration instruments etc. shall be handed over to BHEL site office.

28) The following drawings shall be referred.
   a) PID drawing: Enclosed with purchase Enquiry
   b) Equipment Layout drawing: Enclosed with purchase Enquiry
   c) BOQ for EC&I ITEMS Enclosed with purchase Enquiry
   d) Installation Instructions - 4-WT-310-00017
   e) Instruments Mounting frame Arrangement (Typical) - 3-WT-310-00012
      To 3-WT-310-00025
   f) Instrument Hook up Diagram - 3-WT-310-00026
      To 3-WT-310-00035
## 1.1 ELECTRICAL AND C&I SCOPE OF WORK

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>ELECTRICAL, C&amp;I SYSTEM ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Manufacture / procurement, testing at manufacturer’s works, packing delivery of instruments, Instrument cables, Cable Trays &amp; Junction Box to site</td>
</tr>
<tr>
<td>2</td>
<td>Supply, Receipt of supplied materials at site stores, fabrication of supports for junction box, panels, instruments, Erection &amp; Commissioning of instruments, Junction Boxes (JB’s) &amp; Solenoid Valve enclosure Boxes(SVEB), laying &amp; termination of Cables, erection of Cable Trays (from Equipment to JB) , Pneumatic Operated Valves (POV’s), Control Valve (CV), SVEB at site</td>
</tr>
<tr>
<td>3</td>
<td>Laying &amp; termination of cables between JB &amp; Equipments, Laying &amp; termination of copper tube thro’ Air filter regulator for Pneumatic Operated Valves (POV’s / SVEB), SS impulse tube for Instruments in GI perforated trays with supporting structure etc. at site</td>
</tr>
<tr>
<td>4</td>
<td>Calibration of all instruments at site with standard calibration solutions &amp; standard instruments</td>
</tr>
<tr>
<td>5</td>
<td>Supply of tools required for erection &amp; commissioning of instrumentation system</td>
</tr>
<tr>
<td>6</td>
<td>Carrying out pre commissioning Checks &amp; test at site</td>
</tr>
<tr>
<td>7</td>
<td>Commissioning and putting into satisfactory operation of all instruments at site including successful of trial operation and handing over the system to end user (Customer)</td>
</tr>
<tr>
<td>8</td>
<td>Providing training to BHEL &amp; End user (BHEL Customer) at site</td>
</tr>
<tr>
<td>9</td>
<td>Furnishing the Valve Operating sequence Chart / Control philosophy / Logic Diagram for the system</td>
</tr>
<tr>
<td>10</td>
<td>Furnishing all the drawings, data sheets and documents as per this specification</td>
</tr>
<tr>
<td>11</td>
<td>Extending support by furnishing the required drawings/documents for obtaining approvals from customer for the specification, makes, model numbers of the instruments, GA drawing, if required.</td>
</tr>
<tr>
<td>12</td>
<td>Preparation of Instrument hook up &amp; installation drawings, Cable schedule and Cable Interconnection diagrams</td>
</tr>
<tr>
<td>13</td>
<td>Supply of all applicable drawings as Soft copies in CD.</td>
</tr>
</tbody>
</table>
### 1.2 ELECTRICAL AND C&I SCOPE OF SUPPLY

#### ANNEXURE – ECI- 2

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>ELECTRICAL, C&amp;I SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Supply of Instruments as per enclosed specification / PID / E,C&amp;I Bill Of Quantity (BOQ).</td>
</tr>
<tr>
<td>2</td>
<td>Supply of required erection materials (Mounting skid) for mounting the instruments, Junction Boxes, Cables, Perforated Cable trays, Steel support material &amp; Accessories (From Equipment to Junction Box)</td>
</tr>
<tr>
<td>3</td>
<td>Supply of required Digital &amp; Analog signal cables (2 /4 / 6 / 8 /12 / 24 pair) (From Equipment to Junction Box)</td>
</tr>
<tr>
<td>4</td>
<td>Supply of required Digital &amp; Analog Junction Boxes (12 / 24 / 48 way ) (From Equipment to Junction Box)</td>
</tr>
<tr>
<td>5</td>
<td>Supply of required Perforated Cable Trays to lay the Digital &amp; Analog signal cables (From Equipment to Junction Box)</td>
</tr>
<tr>
<td>6</td>
<td>Supply of required erection materials for Instruments impulse line (Root valves, 2 / 3 / 5 Way manifold for instruments, Drain valves, ½” SS316 SS Tube, SS Fittings, Perforated trays for impulse tube,steel supporting structure etc)</td>
</tr>
<tr>
<td>7</td>
<td>Supply of required erection materials for instrument Air line from Solenoid valve enclosure box to POV’s / SVEB (¼” OD PVC insulated copper tube, Brass Fittings, Air filter regulator, Perforated trays for impulse tube, steel supporting materials etc)</td>
</tr>
<tr>
<td>8</td>
<td>Supply of Instrument air line header (GI Rigid pipe, bends, tees, isolation / Drain valves etc.) for distribution from BHEL Supplied terminal point at one end.</td>
</tr>
<tr>
<td>9</td>
<td>Supply of required Solenoid valve enclosure Box (SVEB) for grouping of Pneumatic Operated Valves and supply of solenoid valve for individual POV</td>
</tr>
<tr>
<td>10</td>
<td>Supply of Commissioning spares as per Annexure ECI-11</td>
</tr>
</tbody>
</table>
## 1.3 ELECTRICAL AND C&I SCOPE OF WORK BETWEEN BHEL & BIDDER

### ANNEXURE – ECI- 3

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>ELECTRICAL SYSTEM</th>
<th>ACTIVITY</th>
<th>AGENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>415V MCC PANEL</td>
<td>SUPPLY ERECTION</td>
<td>BHEL</td>
</tr>
<tr>
<td>2.</td>
<td>LT POWER &amp; CONTROL CABLES</td>
<td>SUPPLY ERECTION</td>
<td>BHEL</td>
</tr>
<tr>
<td>3.</td>
<td>CONTROL CABLES AND INSTRUMENTATION CABLES BEYOND JUNCTION BOX (JB), JUNCTION BOX TO PLC/DCS, PLC/DCS TO LTMCC / VFD</td>
<td>SUPPLY ERECTION</td>
<td>BHEL</td>
</tr>
<tr>
<td>4.</td>
<td>CABLING MATERIAL (CABLE TRAYS, SUPPORT MATERIAL ACCESSORIES AND CONDUITS ETC.) BEYOND JBS, JB TO PLC, PLC TO VFD/LTMCC</td>
<td>SUPPLY ERECTION</td>
<td>BHEL</td>
</tr>
<tr>
<td>5.</td>
<td>LOCAL PUSH BUTTON STATION</td>
<td>SUPPLY ERECTION</td>
<td>BHEL</td>
</tr>
<tr>
<td>6.</td>
<td>EQUIPMENT EARTHING</td>
<td>SUPPLY ERECTION</td>
<td>BHEL</td>
</tr>
<tr>
<td>7.</td>
<td>JUNCTION BOXES / SOLENOID VALVE BOXES</td>
<td>SUPPLY ERECTION COMMG CHECK</td>
<td>BIDDER</td>
</tr>
<tr>
<td>8.</td>
<td>ALL CABLES BETWEEN BIDDER SUPPLIED EQUIPMENT( INSTRUMENTS, POV’S &amp; JUNCTION BOXES / SOLENOID VALVE BOXES)</td>
<td>SUPPLY ERECTION COMMG CHECK</td>
<td>BIDDER</td>
</tr>
<tr>
<td>9.</td>
<td>CABLING MATERIAL (CABLE TRAYS &amp; STEEL SUPPORT &amp; ACCESSORIES) BETWEEN SUPPLIED EQUIPMENT &amp; JUNCTION BOX / SOLENOID VALVE BOX</td>
<td>SUPPLY ERECTION</td>
<td>BIDDER</td>
</tr>
<tr>
<td>10.</td>
<td>CABLE SCHEDULE &amp; CABLE INTERCONNECTION DRG.</td>
<td>PREPARATION ERECTION VETTING</td>
<td>BIDDER</td>
</tr>
<tr>
<td>11.</td>
<td>BELOW GROUND EARTHING, LIGHTING, A/C AND VENTILATION</td>
<td>SUPPLY ERECTION</td>
<td>BHEL</td>
</tr>
<tr>
<td>12.</td>
<td>CONTROLS AND INSTRUMENTATION (AS PER PID ENCLOSED)</td>
<td>SUPPLY ERECTION COMMG.</td>
<td>BIDDER</td>
</tr>
<tr>
<td>13.</td>
<td>PLC/DCS SYSTEM</td>
<td>SUPPLY ERECTION COMMG.</td>
<td>BHEL</td>
</tr>
<tr>
<td>14.</td>
<td>INSTRUMENT AIR LINE DISTRIBUTION FROM BHEL SUPPLIED TERMINAL POINT AT ONE END.</td>
<td>SUPPLY ERECTION COMMG.</td>
<td>BIDDER</td>
</tr>
<tr>
<td>15.</td>
<td>SS IMPULSE PIPING AND FITTINGS</td>
<td>SUPPLY</td>
<td>BIDDER</td>
</tr>
<tr>
<td>FOR INSTRUMENTS</td>
<td>ERECTION</td>
<td>BIDDER</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>----------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td><strong>16</strong> CALIBRATION OF INSTRUMENTS AT SITE WITH BUFFER SOLUTION.</td>
<td>SUPPLY SITE CALIBRATION</td>
<td>BIDDER</td>
<td></td>
</tr>
<tr>
<td><strong>17</strong> IMPULSE PIPING AND BRASS FITTINGS FOR POV'S</td>
<td>SUPPLY ERECTION COMMNG.</td>
<td>BIDDER</td>
<td></td>
</tr>
<tr>
<td><strong>18</strong> PANELS/JB/SVEB/INSTRUMENTS MOUNTING FRAMES</td>
<td>SUPPLY FABRICATION ERECTION</td>
<td>BIDDER</td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**

1. Plug & socket type shall be provided by Bidder for equipment supplied by Bidder.
2. Cable gland & Lugs shall be provided by bidder for equipment supplied by bidder.
3. Cable glands shall be matching to cable sizes where cables are supplied by customer. Cable sizes shall be furnished to the bidder at detailed Engineering stage.
4. Cables other than Power, Control & Screened control cables are special cables.
5. Termination of cables at Bidder supplied equipments by bidder.
6. A separate packing list shall be provided along with the supply for the total no of cable glands & cable lugs. These items shall be packed in a separate wooden box and supplied.

**1.4 List of drawings / documents to be submitted along with offer.**

The bidder shall submit the following documents along with the offer:
- Schedule of Makes of Instruments.
- List of Electrical loads indicating KW etc.

**1.5 List of drawings / data sheet to be submitted to be submitted within 2 weeks from the date of LOI, for the approval of the Purchaser, for all items under the scope of supply:**

- Detailed I/O list
- Instruments Schedule in BHEL format
- List of Electrical loads
- Datasheet for LT Motors in BHEL format
- Data Sheet for Instrument Cables
- Data sheets for all items / instruments in BHEL format
- Cable schedule and Cable Interconnection drawings (For cables in supply and erection scope of Bidder )
- Maintenance instructions for trouble shooting, routine adjustments, assembly & disassembly instructions, off-line testing
- Test certificates for Instruments & LT motors
- Instruments Installation drawings for all items
k) Control Philosophy of MB plant along with Valve Operating Sequence Chart.
l) Instrument Hookup Drawings
2.0 E.C&I SPECIFICATION

ANNEXURE – ECI-4

2.1 SPECIFICATION FOR LT MOTORS

1.0 INTENT OF SPECIFICATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer’s work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors. Maximum rating of the LV motor shall be 160 KW. Motors rated 0.20 KW and below shall be 240v,1Ph,50Hz motors.

2.0 CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

- IS:325 Three phase Induction motors
- IS : 900 Code of practice for installation and maintenance of induction motors
- IS: 996 Single phase small AC and universal motors
- IS: 4722 Rotating Electrical machines
- IS: 4691 Degree of Protection provided by enclosures for rotating electrical machines
- IS: 4728 Terminal marking and direction of rotation rotating electrical machines
- IS: 1231 Dimensions of three phase foot mounted induction motors
- IS: 8789 Values of performance characteristics for three phase induction motors
- IS: 13555 Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
- IS: 2148 Flame proof enclosures for electrical appliance
- IS: 5571 Guide for selection of electrical equipment for hazardous areas
- IS: 12824 Type of duty and classes of rating assigned
- IS: 12802 Temperature rise measurement of rotating electrical machines
- IS: 12065 Permissible limits of noise level for rotating electrical machines
- IS: 12075 Mechanical vibration of rotation of electrical machines
- IS: 12615 Energy Efficient Squirrel Cage Induction Motors

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0 DESIGN REQUIREMENTS
3.1 All LV motors will be suitable for 415V, 3 Phase, 50 Hz power supply. System fault level shall be 50kA for 1 Sec. Design Ambient Temperature of 50°C shall be considered.

3.2 All Motors shall be energy efficient type.

3.3 Motors shall be continuously rated at the design ambient temperature of 50°C and other site conditions specified under Project Information indicated in main equipment specification. Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.4 Starting Requirements

3.4.1 Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.4.2 Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature. The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be as 80% of rated voltage during the starting period of motors.

3.4.3. The motor shall be designed for direct on line starting at full voltage. Starting current shall not exceed 6 times full load current for all auxiliaries, subject to IS tolerance.

3.4.4 The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.

3.4.5 The following frequency of starts shall apply

i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.

ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)

3.5 Running Requirements

3.5.1 Minimum voltage required for starting the motors shall be 80% of rated voltage

3.5.2. Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.
3.5.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage up to 70% of the rated voltage for duration of 2 secs.

3.6 Stress During bus Transfer

3.6.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.6.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.7 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.

3.8 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

3.9 Locked rotor withstand time

3.9.1 The locked rotor withstand time under hot condition at 110% rated voltage shall be more than motor starting time at minimum permissible voltage specified below by at least 3 seconds or 15% of the accelerating time whichever is greater. Provision of speed switch shall be avoided to the extent possible.

3.9.2 Starting time mentioned above is at minimum permissible voltage of 80% rated voltage.

3.9.3 Hot thermal withstand curve shall have a margin of at least 10% over the full load current of the motor to permit relay setting utilising motor rated capacity.

4.0 CONSTRUCTIONAL FEATURES

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691 and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy.

4.2 Motors up to 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362. Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled.

4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.

4.4 Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.
4.5 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

4.6 In case Class ‘F’ insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class ‘B’ insulation. In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10 deg C.

4.7 (iii) Winding and insulation
   All insulated winding shall be of copper.
   Windings shall be impregnated to make them non hygroscopic and oil resistant.

4.8 Noise and vibration
   Maximum noise level measured at a distance of 1 metre from the outer surface of the motor shall not exceed 85 dB(A)
   The peak amplitude of the vibration shall be within IS specified limits.

4.9 Grounding

The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer.

The grounding connection shall be suitable for accommodation of ground conductors as follows:

<table>
<thead>
<tr>
<th>LT Motors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Fractional HP</td>
<td>8 SWG GI wire</td>
</tr>
<tr>
<td>b. Up to 40 KW</td>
<td>25 x 3 mm flat</td>
</tr>
<tr>
<td>c. 41 to 70 KW</td>
<td>25 x 6 mm flat</td>
</tr>
<tr>
<td>d. 71 KW and above</td>
<td>50 x 10 mm flat</td>
</tr>
<tr>
<td>Control Desks, Control/relay panels, LDBs, PDBs, Lighting Panels, Power receptacles, Lighting Masts, Lighting Poles</td>
<td>25 x 6 mm flat</td>
</tr>
<tr>
<td>LPB stations, Limit/Pressure switches, Starters, CT/PT terminal Boxes</td>
<td>08 SWG GI wires</td>
</tr>
<tr>
<td>Columns, Fence, Gates, Cable trays etc</td>
<td>25 x 6mm flat</td>
</tr>
</tbody>
</table>

The cable terminal box shall have a separate grounding pad.

4.10 Terminals and Terminal Boxes

4.10.1 Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified below.
   Unless otherwise stated, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current Short time rating for terminal boxes below 110 kW (Contactor controlled) shall be 50 KA protected by fuse for 0.25 sec.
4.10.2 Unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.

4.10.3 Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or V W & V respectively.

4.10.4 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.

4.10.5 Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable.

4.10.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.

4.10.7 Separate terminal boxes shall be provided for space heaters. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.

4.10.8 Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

4.10.9 Suitable Double Compression type Cable glands and cable lugs shall be provided. Cable lugs shall be of tinned Copper, crimping type. The cable sizes will be informed during detail engineering.

4.10.10 Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size suitable for solidly grounded system shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.11 General

4.11.1 Motors provided for similar drives shall be interchangeable.

4.11.2 Suitable foundation bolts are to be supplied along with the motors.

4.11.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

4.11.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956
4.11.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

4.11.6 Name plate with all particulars as per IS: 325 shall be provided

4.11.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

4.11.8 Necessary cable glands & cable lugs for the motors shall be supplied by the bidder

5.0 INSPECTION AND TESTING

5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the Approved quality plan

5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.

5.3 All motors shall be subjected to routine tests as per IS: 325 Noise level measurement and vibration test as per standards shall be conducted on all motors.

6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

a) OGA drawing showing the position of terminal boxes, earthing connections etc.
b) Arrangement drawing of terminal boxes.
c) Characteristic curves:
   i) Current vs. time at rated voltage and minimum starting voltage.
   ii) Speed vs. time at rated voltage and minimum starting voltage.
   iii) Torque vs. speed at rated voltage and minimum voltage.
   For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
   iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.
DATA SHEET
LT MOTORS (A.C.)

01. Application

02. Type: Energy Efficient IE2

03. Frame size

04. Manufacturer

05. Rated output in KW

06. Duty cycle: Continuous, S1

07. Rated voltage, no. of phases and frequency: 415 V, 3 Ph, 50 Hz

08. Allowed voltage variation: ±10%

09. Allowed frequency variation: ±5%

10. Combined voltage and frequency variation: 10 % (Absolute sum)

11. At rated Voltage and frequency
   a) Full load current (Amps)
   b) Rated speed
   c) Full load efficiency
   d) Full load power factor
   e) Starting torque in % of FLT

12. Method of starting: DOL

13. Degree of protection: IP 55

14. Method of ventilation: TEFC

15. Class of insulation: "F" (temp. rise limited to cl.B)

16. Stator winding connection
   (For continuous run) (Delta / Star)
17. Full load torque : 
18. Breakdown torque in % of FLT : 
19. Pull up torque in % of FLT : 
20. Locked rotor current in Amps : 600% with tolerance of 20% 
21. Motor efficiency and P.F. 
   at 100 % full load : 
22. Locked rotor withstand time 
   under hot/cold condition 
   at 110 % Voltage : 
23. Maximum permissible starting 
   time : 
24. No load current in Amps. : 
25. Starting time in seconds with 
   driven equipment coupled 
   at 80 % voltage : 
26. Actual temperature rise over 
   an ambient of 50°C when motor 
   is delivering rated output 
   a) By thermometer method : 
   b) By resistance method : 
27. Number of successive starts 
   with driven equipment coupled 
   and motor initially at rated 
   load temperature : 
28. Minimum voltage required by 
   the motor to bring the driven 
   equipment to rated speed : To be 80% of RV. 
29. Resistance per phase in ohms 
   at 20 degree : 
30. Direction of rotation viewed 
    from driving end : 
31. Make, type and size of bearing 
   a) At drive end : 
   b) At Non drive end : 

Page 20 of 53
32. Type of mounting and shaft
   Orientation:

33. Location of terminal box:
   viewed from driving end

34. Type and number of terminals
   brought out:

35. Type and size of cable gland:
   (size will be given during Detail engg)

36. Cable gland entry (Top / Bottom):

37. Tropical & fungicidal treatment:

38. GD2 of the motor:

39. Weight of the motor:

40. Drawings To Be Submitted:
   a) OGA drawing showing the position of terminal boxes, earthing connections etc.
   b) Arrangement drawing of terminal boxes.
   c) Characteristic curves:
      i) Current vs. time at rated voltage and minimum starting voltage.
      ii) Speed vs. time at rated voltage and minimum starting voltage.
      iii) Torque vs. speed at rated voltage and minimum voltage.
      For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
   iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.
2.2 SPECIFICATION FOR INSTRUMENTATION CABLE

1.0.0 SCOPE :

The scope of supply of INSTRUMENT CABLE includes design, manufacture, inspection, testing, packing and delivery.

2.0.0 APPLICATION :

The cable to be supplied under this specification is intended to be used for carrying the following signals in RO-DM Plant.

1. 4 – 20 mA DC analogue signals from Transmitters, Analysers, to the PLC Panel.

3.0.0 APPLICABLE STANDARDS :

3.1.0 The INSTRUMENT cable shall be manufactured, tested and packed as per the following standards with their latest amendment. In case of any conflict between these standards and this technical specification, the most onerous shall prevail to the extent of such difference.

IS 1554  PART 1, IS 3975, IS 3961, IS 8130, IS 5831, IS 9938, IS 10418, IS 10810, IS 8784, VDE-0815, VDE 0207 Part - 4, Part – 5, VDE 0816, VDE 0472, ANSI – MC 96.1,

3.2.0 Following standards are additionally applicable for FRLS cable, if FRLS cables are asked for in the Enquiry / Purchase order.

IEEE 3833, IEC 60322-1, ASTMD 2843-7, ASTM 2863-77, IEC 60754 – I, SS 4241475 Clause F3, DIN 53387

4.0.0 SITE ENVIRONMENT :

4.1.0 Ambient temperature : 1 °C to 50 °C.
4.2.0 Relative humidity : 95% at 45 °C.

5.0.0 CONSTRUCTION OF INSTRUMENT CABLE :

The conductors shall be formed by multi-strands and insulated with PVC. Two such cores shall be twisted, and shall be taped with MELINEX and then screened with Aluminium Mylar tape. A drain wire shall be provided for individual pair screen touching the Aluminium. Then a MELINEX TAPE shall be provided on such screened pair for screen isolation. No of screened pair as per enquiry shall be laid up, collectively screened with Aluminium Mylar tape. A drain wire shall be provided for overall screen touching the Aluminium.
Such laid-up cables shall be provided with inner sheath, armoured and outer sheath. Cables shall be suitable for continuous operation at 70 Deg.C.

6.1.0 CONDUCTOR:

6.1.1 Material: High conductivity Annealed tinned copper of electrolytic grade

6.1.2 Cross section area of conductor: 0.5 sq.mm.

6.1.3 Construction: Multi stranded.

6.1.4 Number of strands & Dia: 7 / 0.3

6.1.5 Shape: True circular before stranding, uniform quality free from defects.

6.2.0 INSULATION:

6.2.1 Voltage grade: 1100 V

6.2.2 Material: PVC Compound Type Y 13

6.2.3 Standard applicable: VDE 0207 Part -4

6.2.4 Method of application: Extrusion.

6.2.5 Thickness: 0.4 mm.(Nom.)

6.2.6 Colour: Identification of the cores and pairs shall be done with Suitable colour coding & band marking as well as by Numbering of cores / pairs as per VDE- 0815. The Details of colour coding etc., shall be as approved By the end customer during detailed engg stage.

6.2.6 Shade of colour: As per IS 9938.

6.2.7 Lay length of twin cores: Max. 50 mm. (min. 20 twists per meter)

6.2.8 Sequence of twisting of twin cores: Right hand.

6.3.0 TAPING ON TWISTED PAIR:

6.3.1 Material: MELINEX
6.3.2 Thickness                  :  0.015mm (min)
6.3.3 Coverage                 :  100%.
6.3.4 Overlap                  :  Min 20%

6.4.0 INDIVIDUAL PAIR SCREENING:

6.4.1 Material                :  ALUMINIUM MYLAR TAPE.
6.4.2 Coverage                :  100%.
6.4.3 Overlap                 :  25% (min).
6.4.4 Thickness               :  0.055 mm (min).

6.5.0 DRAIN WIRE FOR INDIVIDUAL SCREENING:

6.5.1 Material                :  Annealed tinned copper.
6.5.2 Area of cross section  :  0.51 sq mm nominal.
6.5.3 No of strands           :  7.

6.6.0 SCREEN ISOLATIONS (INDIVIDUAL PAIR SCREEN):

6.6.1 Material               :  MELINEX.
6.6.2 Coverage               :  100%.
6.6.3 Overlap                :  20%.
6.6.4 Thickness              :  0.015mm (min).

6.7.0 OVERALL SCREEN:

6.7.1 Material               :  ALUMINIUM MYLAR TAPE
6.7.2 Coverage               :  100%.
6.7.3 Overlap                 :  25% (min).
6.7.4 Thickness              :  0.055mm (min).

6.8.0 DRAIN WIRE (OVERALL SCREEN):

6.8.1 Material              :  Annealed tinned copper.
6.8.2 Area of cross section : 0.51 sq. mm (nominal).
6.8.3 No. of strands : 7.

6.9.0 FILLERS (IF PROVIDED) :

6.9.1 Material : Non – hygroscopic, fire retardant, suitable for the operating temp of cable.

6.10.0 INNER SHEATH :

6.10.1 Material : PVC Type YM -1 with FRLS properties
6.10.2 Method of application : Extrusion.
6.10.3 Applicable standard : VDE 0207 PART - 5
6.10.4 Minimum thickness : 0.3mm
6.10.5 Colour : Black.

6.11.0 ARMOURING : Steel (galvanized) wire armouring as per IS-3975 shall be provided. Strip type of armour is not acceptable.

6.12.0 OUTER SHEATH :

6.12.1 Material : PVC Type YM -1 with FRLS properties
6.12.2 Method of application : Extrusion.
6.12.3 Applicable standard : VDE 0207 PART - 5
6.12.4 Minimum thickness : 1.8mm ( VDE – 0816)
6.12.5 Colour : Black
6.12.6 Tolerance on Outer Dia : ± 2mm (max)

6.13.0 ADDITIONAL REQUIREMENT OF OUTER SHEATH:

6.13.1 Oxygen index per : Minimum 29 when tested at 27 +/- 2 Deg.C as per ASTMD 2863-77.
6.13.2 Temperature index: Min.250°C at oxygen index 21 (when tested as per ASTMD 2863-77).

6.13.3 Max. Acid gas generation: Not more than 20% by weight when tested as per IEC 60754 – 1.

6.13.4 Light transmission: Minimum 40% when tested as per ASTMD 2843-7. (Smoke density rating shall be max.60%. This is average value and not instantaneous value).

6.13.5 Flammability: The finished cables shall pass the flammability test as per IEC 60322-1 and IEEE 3833.

6.13.6 Flame resistance: The finished cables shall pass the flame resistance requirement as per category F3 of SS4241475.

6.13.7 Hydraulic Stability and Ultraviolet test: The cables shall pass Hydraulic Stability & Ultra-violet tests as per DIN 53387.
   a. If the test is already conducted on similar size and type of cables, then valid type test certificate of not older than 5 years shall be submitted.
   b. If the test is not already conducted, then the vendor has to conduct the above mentioned tests without financial and commercial implication.

6.14.0 SPECIAL REQUIREMENT OF INSTRUMENT CABLE AT 20°C:

6.14.1 Characteristic impedance @1KHz: 320 (max.)

6.14.2 Mutual capacitance between Conductors at 0.8 KHz: 120 nf / km (max.).

6.14.3 Noise interference: Better than 60 DB.

6.14.4 Attenuation at 1 KHz (max): 1.2 dB/KM.

6.14.5 Cross talk at 0.8 KHz: Better than 60dB

6.14.6 Max.Conductor resistance at 20 deg.C: 73.4 Ohm/Km (loop)

6.14.7 Insulation Resistance: 100 M Ohm / Km (min)

7.0.0 GENERAL REQUIREMENTS:

7.1.0 The cable shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operation conditions.

7.2.0 A distinct inner sheath shall be provided in all twin and multi-core armoured / unarmoured cables.

7.3.0 Repaired cables and cut bit cables will not be accepted.
7.4.0 Progressive automatic on line sequential marking including manufacturer’s name, insulation material, conductor size, no. of pairs, voltage rating, type of the cable etc., progressive marking on the length of the cable at every one metre shall be provided by printing or embossing, on the outer sheath of the cable.

7.5.0 Progressive markings to read “FRLS” at every 5 metres shall be provided by printing or embossing, on the outer sheath of the cables.

7.6.0 Allowable tolerance on overall diameter of the cable shall be ± 2 mm. Variation in diameter and the ovality at any cross section shall not be more than 1.0 mm.

7.7.0 The cables size (No. of cores and conductor cross section) shall be marked on the outer sheath of cable at every 5 metre by printing or embossing.

7.8.0 Other details as called for in IS 1554 part 1 shall also be marked on the outer sheath of the cable by printing or embossing.

7.9.0 The Inner and Outer sheath shall be resistant to Water, UV radiation, fungus, termite and rodent attack.

8.0.0 PACKING AND MARKING:

8.1.0 The cable shall be wound on a non-returnable drum of suitable size and packed.

8.2.0 Cables shall be supplied in wooden or steel drums as per IS 10418. Wooden drums shall be of seasoned wood and shall be free from defects. Wood preservative coating shall be applied on the wood. A layer of non-hygroscopic PVC / polyethylene sheet shall be provided on the axial surface of the drums on the outermost layer of the cable.

8.3.0 The ends of the cable shall be sealed by means of non-hygroscopic sealing material.

8.4.0 The information as detailed in clause 18.2 of IS 1554 (Part – I) shall be stenciled on each drum.

8.5.0 The cables shall be supplied in lengths of 1000 metres.

8.6.0 Tolerance on length of cable in each drum shall be ± 5%.

8.7.0 However if the enquiry / order quantity is less than or equals to 1000m, the entire quantity shall be supplied in a single length.
8.8.0 After winding the cables in 1000 metres in each drum the remaining quantity shall be supplied in single length.

8.9.0 Cut bit cables will not be accepted.

8.10.0 The overall quantity tolerance on each cable size will be – 2%, + 0%.

**9.0.0 INSPECTION AND TESTING :**

The cable shall be inspected and tested based on the following documents.

1. BHEL Technical Specification.
2. BHEL Purchase order.
3. BHEL Approved supplier’s data sheet
4. BHEL Approved QP

*****
ANNEXURE – ECI-6

2.3 SPECIFICATION FOR JUNCTION BOXES & SOLENOID VALVE ENCLOSURE BOXES

2.3.1 JUNCTION BOX

1.0 SCOPE OF SUPPLY:
The scope of supply of Junction box includes manufacturing, inspection, testing, packing and delivery of junction Boxes (painted) as per this specification.

2.0 APPLICATION:
The Junction boxes are used in to interconnect various field-mounted electrical equipment pertaining to RODM plant.

3.0 APPLICABLE STANDARDS:
The Junction boxes shall be manufactured and tested as per the following standards.
   IS 13947 - Low voltage Switchgear and Control Gear specification.
   IS 6005 - Code for Practice for Phosphate Coatings of Iron & Steel.
   IS 694 - PVC insulated Cables for working voltages upto and including 1100V - specification.

4.0 SITE CONDITIONS:
4.1 Ambient temperature: 1 Deg.C to 50 Deg.C
4.2 Relative humidity: 100% RH
4.3 Atmospheric condition: Highly dusty, abrasive and polluted, conducive to fungus growth, climate is tropical. Environment is as prevalent in a coal fired thermal power station.

4.4 Design temperature: 50 Deg.C
4.5 Location: Out door

5.0 GENERAL REQUIREMENTS:
5.1 Enclosure material: 3 mm Cold rolled sheet steel
5.2 Material of Removable gland plate: 3mm Cold rolled sheet steel
5.3 Material of continuous hinge pin, rider clamp, rider spring, washers & rider bolt: SS 316
5.4 Pre Treatment of sheet steel: Seven tank process as per IS 6005.
5.5 General construction: As per drawings forming part of this specification
5.6 Enclosure protection: IP 55 as per IS 13947
5.7 Terminal block type & arrangement: ELMEX CST 2.5 or equivalent type of BHEL approved make mounted on DIN rail
5.8 Terminal block insulating material: Melamine
5.9 Terminal block voltage grade: 650 V (Minimum)
5.10 Door Gasketing: Neoprene gasket 6 mm thick of shore hardness 20 to 30 & density 0.4 gm/cc shall be provided on all mating surfaces.

5.11 Gland plate Gasketing: Neoprene gasket 3 mm thick of shore hardness 30 to 40 & density 0.4 gm/cc shall be provided on all mating surfaces.

5.12 Door Opening: Suitable for 180° opening.

5.13 Lug type: Annealed tinned solder less crimping type copper lugs shall be provided for all the terminals on both sides. Lug type shall be Dowell’s CP-19 pin type (insulated) or equivalent type of BHEL approved make.

5.14 Cable Gland type: Nickel chromium plated Brass Double Compression type cable glands fixed on the gland plate, with dummy plugs.

5.15 Cable Gland size & quantity: As required

5.16 Number of earthing terminals: Two.

5.17 Size & location of earthing terminals: As required

5.18 Location of earthing symbol: Just above the earthing terminal. Symbol to be black lines on yellow background.

5.19 Rated voltage grade of junction box: 415V.

5.20 Mounting fasteners: 4 sets of chromium plated bolts, nuts and spring washers for mounting the JB shall be supplied.

5.21 All seams are to be continuously welded. There shall be no holes or sockets on top and sides.

5.22 Suitable DIN rails along with clamps and screws shall be provided for terminal block mounting. All terminals are to be numbered serially by suitable identification label of PVC material in white background with black numbers. Terminal blocks shall be fixed to T.B supporting DIN rail by means of suitable end plates with screws. Stickers have to be fixed over the cable glands to indicate the cable size.

5.24 Rolled lip shall be provided around three sides of door and around all sides of enclosure opening. This lip is to increase the strength and to keep dirt and liquid from dropping into the enclosure when the door is opened.

5.25 Name plate of 2 ply lamicoid in white colour with the inscription in black letters shall be fixed to the name plate mounting bracket on top of the junction box with plated screws.

5.26 The untoleredced dimensions shall be as per IS 2102.

6.0 MAKE OF COMPONENTS
6.1 Terminal block: ELMEX / CONNECTWELL / TOSHA CONTROLS & SWITCHGEAR / WAGO
6.2 Crimping type lug: DOWELLS / JAINSON / LOTUS
6.3 Cable glands: COMET / BRACCO / ANUP ENGG. / QUALITY PRECISION / SUNIL & Co. / SIEMENS / CONTROLS & SWITCHGEAR / SCHNEIDER

7.0 PAINTING

The JB shall be painted with two coats of epoxy based Zinc Chromium primer and finally finished with two coats of epoxy paint as follows.

Exterior & Interior: Light grey shade 631 as per IS 5.
Finish: Semi Glossy
Paint thickness: 50 microns.

8.0 PACKING
Each JB shall be fully wrapped in a polythene cover to avoid water entry and then packed separately in cardboard box. Finally all such boxes shall be packed in a wooden crate.

9.0 DRAWING
JB Manufacturing drawings such as General Arrangement, Mounting Arrangement, Terminal Block Details in AUTO CAD/PDF shall be submitted for approval by BHEL, (prior to start of manufacture) within 10 days from the date of purchase order.

2.3.2 SOLENOID VALVE ENCLOSURE BOX (SVEB)

1.0 The solenoid valves shall be provided suitably as per the process requirement with corresponding SVEBs. The bidder shall locate the required no. of solenoid valves inside the enclosure box and do the tubing and wiring. The solenoid valve coil wires shall be terminated in a terminal block located inside the enclosure box. The inlet ports of the solenoid valves shall be connected to a common inlet manifold to which the air supply will be connected at site using a Air Filter Regulator (AFR). The outlet / vent connections of the solenoid valve shall also be connected to respective manifolds in each SVEB using SS 316 compression type tube fittings. The external tubing & wiring connections from the SVEB to the respective POV shall be taken care of by Bidder at site. The Terminal blocks for wiring the POV limit switches shall be located inside the respective SVEB.

2.0 CONSTRUCTION:
The Solenoid Valve Enclosure Box (SVEB) shall be made from Cold rolled Sheet Steel Min 3 mm. The doors shall be hinged type. The enclosure shall be suitable for IP 55. Single piece Neoprene gasket of suitable thickness shall be provided on all mating surfaces to ensure watertight seal. Enclosure
box shall have 4 fixing lugs & shall be suitable for wall mounting or angle iron frame mounting.

2.1 SOLENOID VALVE:

a) Quantity : 01 No. for each POV actuator.
b) Type : Single coil solenoid valve suitable for the diaphragm actuator with needle type flow control valve to adjust valve closing / opening speed.
c) Body : Bronze
d) Plunger : SS316
e) Pressure range : 5 to 8 Kg/sq. cm
f) Duty : Continuous
g) Coil Voltage : 24 V DC.
h) Air Connection : ¼" NPT(F)
i) Protection : Weather proof IP65.
j) Class of insulation : “ F “
l) Shut off class : Class IV
m) Make : As per vendor list enclosed with the enquiry.

3.0 Painting:

a) Exterior : Epoxy based paint. Light grey (Shade : 631) as per IS-5. Paint thickness 100 microns. Finish – Semi Glossy

b) Interior : Epoxy based white paint. Paint thickness 50 microns. Finish – Glossy

C) The following items are to be located in each SOV enclosure box and the box shall be sized to accommodate the same.

a) Solenoid valves – as required POVs for a filter.
b) Terminal Block (required No. of ways) – 1 Set.,
c) Cable Entry ; Bottom only
d) Double compression cable gland suitable for 2 pair x 0.5 sq. mm PVCA cable – As required for limit switch outgoing cables.
e) Double compression cable gland suitable for 8 pair x 0.5 sq. mm PVCA cable – As required for limit switch/Solenoid valve incoming cable.

Necessary SS316 tubing and compression fittings are to be supplied and mounted inside the enclosure Box for connection of the SOVs located inside. The solenoid valve coils are to be wired to the terminal block by using 650V grade PVC insulated, 2.5 sq. mm stranded Copper flexible wire. One No. ATC crimp type lug shall be provided on both sides of each TB. Earthing bolts & nuts with lug shall be provided at opposite points on outside of the junction box with earth symbol.
Name plate with suitable inscription shall be provided for each box. The inscription details will be informed after ordering.

Incoming line size & common header : ½” SS316 Tube
Outgoing line size (To POVs) : ¼” OD PVC Insulated Copper Tube
Exhaust line size & Common header : ½” SS316 Tube

Terminal Block  Make : ELMEX, TOSHA OR CONNECTWELL
Cable Gland : Make: COMET, SIEMENS, SUNIL
Cable Lugs : Make: DOWELLS, JAINSON, LOTUS
Wires : Make: RELIANCE, RPG, NICCO, UNIVERSAL, FORT GLOSTER, DELTON, CCI,

8.0  PACKING
Each SVEB shall be fully wrapped in a polythene cover to avoid water entry and then packed separately in cardboard box. Finally all such boxes shall be packed in a wooden crate.

9.0  DRAWING
SVEB Manufacturing drawings such as General Arrangement, Mounting Arrangement, Terminal Block Details in AUTO CAD/PDF shall be submitted for approval by BHEL, (prior to start of manufacture) within 10 days from the date of purchase order.
ANNEXURE – ECI- 7

2.4 GENERAL REQUIREMENTS

1.01.00 Instruments for sensing, transmission and measuring system shall be of electronic type with signal transmission in current mode of 4-20 mA DC. For interrogation of potential free Contacts, 48V DC power supply shall be employed.

1.02.00 Tripping contact for unit as well as for equipment shall be separate from interlock and alarm contacts. Also the tripping contact for equipment and unit shall be separate. The protection system shall conform to the relevant standard as indicated in clause

1.03.00 Indicating type process switches deriving contact from pointer shall not be acceptable wherever blind switches are provided, separate gauges for local indication shall be provided to facilitate easy operation / maintenance.

1.04.00 The contacts of switch devices (process switches, limit switches) etc. unless higher rating is required for specific application, shall be rated continuously for 5A at 240 V AC, 50 Hz (breaking inductive circuits) and 0.25 A at 220V DC. Each switching element including the contacts from limit and torque switches of valve actuators shall be provided with two contacts. All spare contacts of the switch devices, shall be wired to the nearest junction box/ terminal box.

1.05.00 All electronic modules shall have gold plated connector fingers and further all input and output modules shall be short circuit proof. These shall also be tropicalised & components shall be of industrial grade or better.

1.06.00 All equipment/systems located in the field shall be suitable for continuous operation without loss of function, departure from specifications or damage, at the ambient temperature of 50 deg.C and relative Humidity 95%.

All electrical & electronic equipments located in hazardous areas shall be provided with explosion proof enclosures safety barriers manufactured according to internationally accepted codes NEC, BASEEFA, CENELEC, JIS, VDE, CEL, UTI etc. Applicable protection certificates (explosion proof, intrinsic safe etc.) shall be furnished for equipment to be installed in areas classified as hazardous.

Bidder must clearly bring out in his proposal the hazardous area classification for the entire plant in accordance with International codes.

1.07.00 All equipment/systems located in air conditioned areas shall also be designed and constructed to operate for short periods of plant operation when air-conditioning equipment malfunctions (without loss of function,
departure from specifications requirements or damage) at the maximum ambient temperature of 50 deg. C and relative humidity of 95%. RH.
ANNEXURE – ECI- 8

2.5 MEASURING INSTRUMENTS GENERAL

1.1 Measuring instruments / equipment and subsystems offered by the bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Further, all instruments shall be of proven reliability, accuracy, and repeatability requiring a minimum of maintenance. They shall comply with the acceptable international standards and shall be subject to Employer's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specifications, ranges, makes / numbers as approved by the Employer during detailed engineering.

1.2 Every panel-mounted instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.

1.3 All local gauges as well as transmitters, sensors, and switches for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance as well as for operator and management information (including all computation) of equipment in the system under the scope of specification shall be provided. The Bidder shall furnish all Instrumentation / Control equipment & accessories under this specification as per technical specification, ranges, makes & model as approved by the Employer during detailed engineering.

1.4 The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting/erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments, sensors; switches etc. for external connection including spare contacts shall be wired out in flexible/ rigid conduits, independently to suitably located common junction boxes. The proposal shall include the necessary cables, flexible conduits, junction boxes and accessories for the above purpose.

1.5 SELECTION OF RANGES FOR INSTRUMENTS

The ranges of the instruments shall be selected based on the following Philosophy Indicated below:

For pressure measurements, the maximum operating pressure will be Within 70 to 80% of the maximum scale range. All pump suction measurements will cover the negative pressure range also.
For temperature measurement, the maximum operating temperature will be within 80 to 90% of the maximum scale range.

For pressure switches and temperature switches, the set points shall fall within 40% to 70% of the scale range selected.

For level measurement, the maximum of the range will cover the overflow point or six inches from the top of the vessel and the minimum of the range will be six inches above the bottom of the vessel. Also, the gauge glasses will be stacked with overlap to cover permissive, alarm and trip levels.

For flow measurement, the maximum range shall be fixed at about 10 to 15% above the maximum operating flow.

For electro-chemical measurements (conductivity, pH, Silica etc.), the maximum Range will be around 10 to 15% higher than the recommended alarm settings.

2.00 TRANSMITTERS

2.01 SPECIFICATION FOR ELECTRONIC TRANSMITTER FOR PRESSURE, D.P., FLOW AND LEVEL ELECTRONIC TRANSMITTERS

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Features</th>
<th>Essential/Minimum Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Type of Transmitter</td>
<td>Microprocessor based 2 wire type, Hart protocol compatible.</td>
</tr>
<tr>
<td>2.</td>
<td>Accuracy</td>
<td>± 0.1% of calibrated span (minimum)</td>
</tr>
<tr>
<td>3.</td>
<td>Output signal Range</td>
<td>4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol)</td>
</tr>
<tr>
<td>4.</td>
<td>Turn down ratio</td>
<td>10:1 for vacuum/very low pressure applications.30:1 for other applications.</td>
</tr>
<tr>
<td>5.</td>
<td>Stability</td>
<td>± 0.1% of calibrated span for six months for Ranges up to and including 70 Kg/cm². ± 0.25% of calibrated span for six months for Ranges more than 70 Kg/cm²(g).</td>
</tr>
<tr>
<td>6.</td>
<td>Zero and span</td>
<td>+/- 0.015% per deg.C at max. span. +/- 0.11% per drift deg.C at min. span.</td>
</tr>
</tbody>
</table>
7. Load impedance  500 ohm (min.)

8. Housing  Weather proof as per IP-55 with durable corrosion resistant coating.

9. Over Pressure  150% of max. Operating pressure

10. Connection (Electrical)  Plug and socket type

11. Process Connection  1/2 inch NPT (F)

12. Span and Zero  Continuous, tamper proof, Remote as well as adjustability manual from instrument with Zero suppression and elevation facility.

13. Accessories  - Diaphragm seal, pulsation dampeners, Siphon etc. as required by service and operating condition.

   - 2 valve manifold for absolute pressure Transmitters (3-valve manifold for gauge / vacuum pressure transmitters) and 5 valve manifold for DP/level/flow transmitters.

   - For hazardous area, explosions proof enclosure as described in NEC article 500.

14. Diagnostics  Self Indicating feature

15. Power supply  24V DC ± 10%.

16. Adjustment /calibration/ maintenance  Centralised PC based system. In addition total two (2) nos. of hand- held type universal calibrators per module, compatible with HART protocol, shall be provided.

Notes:
In case it becomes necessary to use a DP transmitter for pressure measurement then a 3-valve manifold should be used in place of 2-valve manifold. LVDT type is not acceptable.

Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.
### 4.00 SPECIFICATION FOR PR. GAUGE, D.P. GAUGE, TEMP. GAUGE AND LEVEL GAUGE.

#### Sl. FEATURES

<table>
<thead>
<tr>
<th>No.</th>
<th>Features</th>
<th>ESSENTIAL / MINIMUM REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sensing Element and material</td>
<td>Pr. Gauge/ DP Gauge/ Draught gauges</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Temperature Gauge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level Gauge*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Body material</td>
<td>Bourdon for high pressure, Diaphragm/ Bellow for low Pr. of 316 SS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mercury in steel for below 450°C and inert gas actuated for above 450°C of SS bulb and capillary.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tempered, toughened Borosilicate gauge glass steel armoured Reflex or Transparent type</td>
</tr>
<tr>
<td>3</td>
<td>Dial size</td>
<td>150mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>150 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>End connection</td>
<td>1/2 inch NPT (F)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3/4&quot; NPT (F)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Process connection as per ASME PTC and Drain / vent 15 NB</td>
</tr>
<tr>
<td>5</td>
<td>Accuracy</td>
<td>±1% of span</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 1% of span</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 2%</td>
</tr>
<tr>
<td>6</td>
<td>Scale</td>
<td>Linear, 270° arc graduated in metric units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Linear, 270° arc graduated in °C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Linear vertical</td>
</tr>
<tr>
<td>7</td>
<td>Range selection</td>
<td>Cover 125% of max. of scale</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cover 125% of max. of scale</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cover 125% of max. of scale</td>
</tr>
<tr>
<td>8</td>
<td>Over range test</td>
<td>Test pr. for the assembly shall be 1.5 to the max. Design pr. at 38°C.</td>
</tr>
<tr>
<td>9</td>
<td>Housing</td>
<td>Weather and dust proof as</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weather and dust proof as</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CS/304 SS leak proof</td>
</tr>
</tbody>
</table>
per IP-55 per IP-55

10 Zero/span 
   adjustment Provided Provided –

11 Identification Engraved with service legend or laminated phenolic 
   name plate

12 Accessories Blow out disc, siphon, snubber, 
   pulsation dampener, 
   chemical seal 
   (if required by 
   process) gauge 
   isolation valve 
   SS Thermowell 
   Gasket for all 
   KEL-F shield 
   for transparent 
   type vent and 
   drain, valves of 
   Steel/SS 
   as per CS/Alloy 
   process 
   Requirement.

13 Material of 
   Bourdon/ 
   movement 316 SS / 304 SS 316 SS / 304 SS

Notes:-

* Bicolour type level gauges will be provided for application involving 
  steam and water except for condensate and feed water services

Length of gauge glass shall not be more than 1400 mm. If the vessel is 
higher, multiple gauge glasses with 50 mm overlapping shall be 
provided.

Where the process fluids are corrosive, viscous, solid bearing or slurry 
type, diaphragm seals shall be provided. Parts below the diaphragm 
shall be removable for cleaning. The entire volume above the 
diaphragm shall be completely filled with an inert liquid suitable for the 
application.

5.00 BYPASS ROTAMETERS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Features</th>
<th>Essential / minimum requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Type</td>
<td>Orifice plate bypass type</td>
</tr>
<tr>
<td>2.</td>
<td>Fluid media</td>
<td>Water</td>
</tr>
<tr>
<td>3.</td>
<td>Tube body</td>
<td>SS316</td>
</tr>
<tr>
<td>4.</td>
<td>Material of float</td>
<td>316 SS</td>
</tr>
</tbody>
</table>
5. Indicator  
   Linear scale  

6. Accessories  
   Flange, orifice in case of bypass  
   Rota meter (for line size above 100 mm)  

7. Housing protection class  
   IP-55  

8. Accuracy  
   + 2% of measured value.  

9. Repeatability  
   +/- 0.5% of full scale.  

10. Flow rangeability  
    Greater than 3  

11. Packing  
    Teflon  

6.00 PROCESS ACTUATED SWITCHES  

FEATURES  ESSENTIAL / MINIMUM REQUIREMENTS  

<table>
<thead>
<tr>
<th>Pressure/ Temperature</th>
<th>Level switches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draft Switches/ DP Sw</td>
<td>Vapour pressure for high pressure filled bellow type With SS bulb and capillary (10M minimum)</td>
</tr>
</tbody>
</table>
| Sensing | Float type switches sensing, liquid for medium, Condensate application.  
| Piston actuated types Element and diaphragm or bellows for low pr. / Vacuum |

| Material | 316 SS |
| Bulb | 316 SS/ capillary 304 SS |

| End connection | ½ inch NPT (F) |
| ½ inch NPT (F) | Manufacturer standard |

| Over range proof | 150% of max. design pr. |
| - | 150% of max. design Pressure |

| Repeatability | + 0.5% of full range |

| No. of contacts | 2 No.+2NC. SPDT snap action dry contact |

| Rating of contacts | 60 V DC, 6 VA- (or more if required by DDCMIS |

| Elect. Connection | Plug in socket |
| Set point/ | Provided over full range |
dead band adjustment

Enclosure Weather and dust proof as per IP-55

Accessories
- Siphon, snubber, Chemical seal
- Pulsation dampeners as required by process
- Thermo well of 316 SS and packing glands
- All mounting accessories

Mounting
- Suitable for enclosure/ rack mounting or
- Suitable for rack mounting or direct mounting
- Direct mounting

Power Supply
- 24 V DC to be arranged by Bidder except for Ash level switches where the same shall be as per Bidder’s Standard practice (wherever Required)

Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

6.01 FLOW SWITCHES
Flow Switches shall be with paddle & bellows sensors with paddle MOC of SS316 & Bellows MOC SS 316L. Wetted parts shall be SS316. Enclosure shall be Die Cast Aluminuim with weather proof to IP66 and suitable for ambient temp of 50 deg C. Mounting shall be vertical/direct on line. Electrical connection shall be through 7 pin plug-in connector. Suitable process connection shall be selected. Range shall be suitable for process requirement with repeatability of ±2% of Full Scale Reading. The switches shall be SNAP acting Micro Switches suitable for 240V AC, 15A with 2 NO + 2 NC SPDT Dry Contact. The set point adjustability should be over the full range.

7.00 SPECIFICATION FOR FLOW ELEMENTS
7.01 Orifice Plate

Features

<table>
<thead>
<tr>
<th>Essential/Minimum Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Concentric as per ASME PTC-19.5 (Part-II), SA RP-3.2, 1960 or BS-1042</td>
</tr>
</tbody>
</table>
Material | 316 SS
---|---
Thickness | 3mm for main pipe diameter upto 300mm and 6mm for main pipe dia above 300 mm.
Material of branch pipe | Same as main pipe
Root valve type | Globe / Needle
Root valve material | 316 SS
Root valve size | 1 inch
Impulse pipe of same material up to root valve | Required
Tappings | Flanged weld neck. 3 pairs. of tapping.
Beta Ratio | 0.34 to 0.7
Beta Ratio calculation to be submitted | Yes
Assembly drg. and flow Vs DP Curves | Yes
Accessories | Root valves, flanges, Vent/drain hole (As required)

Bidder shall submit certified flow calculation and differential pressure vs. flow curves for each element for Employer's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Employer's approval. One Flow element of each type shall be calibrated in the test laboratory for validation of commutated flow calculations.

Each flow element shall have the name plate engraved on the element. This name plate shall have details of tag no, make, serial no, body material, beta ratio, line size, thickness, flow direction etc. as minimum. All these details shall also be put on the additional tag plate attached to the flow element, which shall be easily visible from outside of the insulation.
**Air Filter Regulator (AFR)**
Constant bleed type AFR with an accuracy of +0.1%, inlet pressure range of 5-8 kg/cm² and suitable spring ranges (AFR) for use with positioners in control valves, control damper, E/P converters and shut off valves for phosphor bronze filter element; Filtering particles above five microns. Weather and water proof enclosure. Material of accessories will be SS.

Air filter regulators shall be provided in the:
(a) Air supply line to valve positioners / power cylinders
(b) Air supply line to electric to pneumatic converters.
(c) Air supply line to pneumatic interlocked block valves.
(d) For each instrument rack, field instruments enclosure for purging.

**SPECIFICATION FOR SILICA ANALYSER**

01. **Item**: Silica Analyser
02. **Application / Medium**: To suit the system requirement.
03. **Ambient Temperature**: 50 Deg.C.
04. **Surrounding Atmosphere**: Dusty, humid & corrosive atmosphere. Relative humidity - 100%.
05. **Design Condition**: To suit the system requirement.
06. **Scope of Supply**: Analyser is to be offered as a complete working system along with the necessary sample conditioning system, if any, reagent chemicals, Indicator etc. housed in an enclosure.

07. **Analyser**:
a) **Type**: Solid State / Microprocessor based
b) **Make**: As per Approved Vendor’s list
c) **Range**: 0.00 to 5000 ppb as SiO₂, Auto ranging.
d) **Accuracy**: ± 2 ppb
e) **Minimum Detection Limit**: 0.5 ppb
f) **Number of sample streams**: 3 (Three)
g) **Response Time**: Better than 12 min. for 90% change.
h) **Calibration**: Auto & Manual calibration, Programmable on front key board.
i) **Features**: Auto Zero & span calibration, Ambient temperature Compensation.
j) **Indicator**: Integral
k) **Display**: LCD display with backlit.
I) Recorder Outputs: Single / Dual 4-20mA DC isolated linear signal.

m) Alarms (Self Diagnostic feature):
   a) No reagent
   b) Calibration Fault
   c) Silica Concentration High
   d) Analyser system shutdown.

n) Power Supply: 240V, 50Hz, 1ph, AC

o) Housing: Corrosion proof plastic enclosure, weather water proof.

p) Mounting: To suit Bench top / Wall / Panel mounted type.

q) Cable Termination: Terminal block to suit 2.5 sqmm wires.

08. **Calibration Solutions**:
   Calibration solutions, if any, required during commissioning of the system should be offered as part of the Silica Analyser. Offer for the same should also be given for periodic calibration.

09. **Reagent Chemicals**:
   Bidder to supply the Analyser with 1 set of reagent chemicals in Standard package. Bidder to submit offer for reagent chemicals mentioning the periodicity of replacement. Bidder to supply reagents as commissioning spares in addition to supply made for silica analyser in standard package.

10. **Reagent Chemical Guarantee**:
    Bidder to submit guarantee for reagent consumption. If the Quantity Consumption exceeds the guaranteed quantity, Bidder shall supply the additional quantity of reagent free of cost. This guarantee shall be valid for the guarantee period.

**SPECIFICATION FOR pH ANALYSER**

01. Item: pH Analyser

02. Application / Medium: To suit the system requirement.

03. Ambient Temperature: 50 Deg.C.

04. Surrounding Atmosphere: Dusty, humid & corrosive atmosphere. Relative humidity - 100%.

05. Design Condition: To suit the system requirement.

06. **Sensor**:
   a) Installation: Mounted on bypass line. Flow through chamber or Tee to be offered for bypass line installation.
   b) Measuring Electrode: Double junction, combined electrode
housed in tough, corrosion proof body.

c) Accessories
   i) Pre-Amplifier if required
   ii) Screened junction box for electrodes.

d) Temperature Compensation
   : Automatic (integral) upto 0-100 °C.

e) Wetted Parts
   : Bidder to select suitable for the medium.

f) Sensor Connection
   : Suitable for threading to flow thro' chamber mounted on bypass line.

g) Sensor to Indicator Cable Length
   : 10 Mtrs. (Per mtr. Rate to be offered for ordering additional length, if required).

07. Analyser:
   a) Type
      : Solid State / Microprocessor based

   b) Scale Range
      : 0-14 pH

   c) Mounting
      : Wall / Panel / Pipe mounted type

   d) Protection Class
      : NEMA 4X, IP 65, weather & water proof

   e) Display
      : Digital.

   f) Temperature Compensation
      : Automatic (-15 to 100 Deg. C)

   g) Calibration
      : Calibration with standard

   m) Features
      : a) Zero & span adjustableAuto zero check

   n) Output
      : Single / Dual 4-20 mA Isolated

   o) Alarms
      : pH High/Low

08. Performance:
   a) Accuracy
      : ± 0.02 pH

   b) Power Supply
      : 240V, 50Hz, 1ph, AC

   c) Cable Termination
      : Terminal block to suit 2.5 sqmm wires.

   d) Stability
      : +/- 0.01 pH / Month, non cumulative

SPECIFICATION FOR CONDUCTIVITY ANALYSER

01. Item
    : Conductivity Analyser

02. Application / Medium
    : Demineralised Water.

03. Ambient Temperature
    : 50 Deg.C.

04. Surrounding Atmosphere
    : Dusty, humid & corrosive atmosphere.
      Relative humidity - 100%.

05. Design Condition
    : To suit the system requirement.

06. Sensor:
    a) Installation
      : Mounted on bypass line. Flow through chamber or Tee to be offered for bypass line installation.
b) Measuring Electrode : Unbreakable electrode housed in tough, corrosion proof body.

c) Preamplifier (if required) : Integral with the sensor.

d) Temperature Compensation : Automatic (integral) upto 0-100 °C.

e) Wetted Parts : Bidder to select suitable for the medium.

f) Sensor Connection : Suitable for threading to flow thro' chamber mounted on bypass line.

g) Sensor to Indicator Cable Length : 10 Mtrs. (Per mtr. Rate to be offered for ordering additional length, if required).

07. Analyser :

a) Type : Solid State / Microprocessor based

b) Scale Range : To suit the system requirement.

c) Mounting : Wall / Panel / Pipe mounted type

d) Protection Class : IP 55, weather & water proof

e) Display : LCD / LED with alarm status and Indications.

f) Temperature Compensation : Automatic (0-100 Deg. C)

g) Calibration : Calibration with standard buffer solution.

h) Alarms : High

i) Accessories : 2 Adjustable set points

j) Output Signal : Single / Dual Isolated 4-20 mA DC linear signal.

k) Enclosure : Corrosion proof plastic enclosure.

l) Auto Calibration : To be provided.

m) Features : Zero Check.

08. Performance:

a) Accuracy % FSD : ± 1

b) Power Supply : 240V, 50Hz, 1ph, AC

c) Cable Termination : Terminal block to suit 2.5 sqmm wires.

d) Stability : 0.5% of reading / month.
2.6 SPECIFICATION FOR PNEUMATIC ACTUATOR

01 ACTUATOR:

a) Quantity: 01 No. for each Pneumatic Operated Valve (POV)
b) Type: Pneumatic Diaphragm Actuator, Double / single acting (as per process requirement)
c) Action: Air to Open & Air to Close
d) Pressure: 5 to 8 Kg /sq. cm
e) Air Connection: ¼” NPT(F) copper tube.
f) Local Position Indicator: To be provided.
g) Hand wheel for manual operation: Required
h) Speed adjustment for Actuator operation: To be provided to facilitate speed adjustments both during opening & closing by means of flow control valve.
i) Action of driving equipment on air failure: Stay put
j) Type of operation:
   I) Solenoid Valve Energised for valve to open & Solenoid Valve De-energised for valve to close
   OR
   II) Solenoid Valve De-energised for valve to open & Solenoid Valve Energised for valve to close

The above requirement shall be informed during order Execution stage for each POV. Bidder to supply accordingly.
k) Actuator Make: As per vendor list enclosed with the enquiry.

02 LIMIT SWITCHES:

a) Quantity: One for Open & one for Close position for each POV.
b) No. of Contacts: Two normally open & two normally closed potential free contacts in each limit switch corresponding to open & close positions of the valve.
c) Contact Rating: 5A, 240V AC, 0.5A, 220 V DC
d) Protection: Weather proof IP 55.
e) Cable Gland: Suitable for 2P x 0.5 sq mm PVCA cable.
f) Limit Switch Box: Limit Switch terminals shall be brought out to a Terminal Box

NOTE:
All the analysers / cells shall have open corrosion resistant SS drain channel to waste header.

All chemicals reagents required for 12 months operation is to be supplied in phased manner depending on shelf life in addition to that indicated under mandatory spares. Availability of chemical reagents for future use shall be ensured from indigenous source.

Two years consumable kits for each analyser shall be supplied with each analyser. This shall be over and above the standard consumable kit supplied by OEM for commissioning of analyser.
2.7 IMPULSE PIPING, TUBING, FITTINGS, VALVES AND VALVE MANIFOLDS

1.01 All impulse pipe shall be of seamless type SS316 material.

1.02 The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifold and all the other accessories required for mounting/erection of the local instruments shall be furnished, even if not specifically asked for, on as required basis. The instrument fittings shall be of forged SS. Instrument piping shall be designed for maximum design pressure & temperature of the process. Pressure instrument connection shall be ½" or 12 mm pipe connection. The contacts of equipment mounted instruments, sensors, switches etc for external connection including spare contacts shall be wired out to the LCP.

1.03 The valve manifolds shall be of 316 stainless steel with pressure rating suitable for intended application. 2-valve manifold and 3-valve manifold shall be used for pressure measurements using pressure transmitters/ pressure switches and differential pressure transmitter/ switches respectively. 5-valve manifold shall be used for remaining applications like DP, flow and level measurements.

1.04 For Pr. / D.P gauges in fluid application two-way globe valve on each impulse line to the instrument and in Air / Flue gas application two-way gate valve on each impulse line to the instrument shall be provided near the instrument. These shall be in addition to the three ways gauge cock provided along with the pr./D.P gauges.

1.05 All the threaded tube fittings used in the plant shall be of the NPT type threading. All the tapping points and pipe to tube joints shall also be using the NPT type threading. Any deviation from the NPT type threading shall be Notified to the Customer specifically for the ease of the maintenance.

1.06 Tube Fittings:

1.06.1 All the threaded tube fittings used in the plant shall be of Stainless Steel double compression type.

1.06.2 All fittings used in the impulse tubing / piping except the last fitting connecting the instrument shall be socket welded.

2.00 AIR SUPPLY PIPING

2.01. All pneumatic piping, fittings, valves, air filter cum regulator, purge rotameter and other accessories required for instrument air for the various pneumatic devices/instruments shall be provided.

2.02 This will include as a minimum air supply to pneumatically operated control valves, actuators, instruments, continuous and intermittent purging requirements etc.
2.03. For individual supply line and control signal line to control valve, 1/4-inch size light drawn tempered copper tubing conforming to ASTM B75 shall be used. The thickness of cu-tubing shall not be less than 0.065 inch and shall be PVC coated. The fittings to be used with copper tubes shall be of cast brass, screwed type.

2.04 All other air supply lines of 1/2 inch to 2 inch shall be of mild steel hot dipped galvanized inside and outside as per IS-1239, heavy duty with threaded ends. The threads shall be as per ASA B.2.1. Fittings material shall be of forged carbon steel A234 Gr. WPB galvanized inside and outside, screwed as per ASA B2.1. Dimensions of fittings shall be as per ASA B16.11 of rating 3000 lbs.

2.05. All instrument air filters cum regulator set with mounting accessories shall be provided for each pneumatic device requiring air supply. The filter regulators shall be suitable for 10-kg/ sq.cm max. inlet pressure. The filter shall be of size 5 microns and of material sintered bronze. The air set shall have 2-inch size pressure gauge and built in filter housing blowdown valve. The end connection shall be 1/4 inch / 1/2 inch/ 3/4 inch NPT as per the requirement to be finalised during detailed engineering.

2.06 All the isolation valves in the air supply line shall be gate valves as per ASTM B62 inside screw rising stem, screwed female ends as per ASA B2.1. Valve bonnet shall be union type & trim material shall be stainless steel, body rating 150 pounds ASA. The valve sizes shall be ½ inch to 2 inch.

3.00 INSTALLATION AND ROUTING

3.01. All instrument piping, tubing and its accessories shall be supported in a safe manner to prevent excessive vibrations and anchored sufficiently to prevent undue strain on connected equipment. Instrument piping & tubing shall not be routed across equipment removal areas, above or below monorails, cranes, removable gratings, cable trays.

3.02. Instrument Air & Service Air Piping/ Tubing System

3.02.01 The air supply headers, sub-headers and branch pipes shall be supported properly by clamps or supports to be provided and fabricated by the Bidder. Air supply piping shall be installed with a slope of over 1/100 to prevent accumulation of condensed water within the pipe. Signal/control air tubings shall run with the minimum number of changes in direction. Suitable identification tags shall be provided for easy link up and checking of proper connections. Single and multi tubes shall run with the minimum number of changes in direction. Suitable identification tags shall be provided for easy check-up and for connections.

4.00. PIPING/ TUBING SUPPORT
4.01. Impulse piping and sample piping shall be supported at an interval not exceeding 1.5 meters. Each pipe shall be supported individually using slotted angle mounted clamps with necessary fixtures. Tubing shall run in proper perforated trays with proper cover. Tubing shall be supported inside the trays by aluminium supports. Hangers and other fixtures required for support of piping and trays shall be provided, either by welding or by bolting on walls, ceilings and structures. Hanger clamps and other fastening hardware shall be of corrosion resistant metals and hot-dip galvanized.

5.00 **Cable trays, support systems and pipes**

5.01 **Support system**
Cable trays/junction box/SVEB supports shall be made of MS angles/channels cut to size and welded at site to suit the requirement.

5.02 **Type of cable trays**
Material of cable tray Shall be Rolled mild steel, min. 2.5 mm thick for trays and 3mm thick for coupler plate. Finish of cable trays Shall be hot dip galvanised Trays. Length of the cable trays shall be 2.5 metres.

5.03. The cable sub-trays and the supporting system, to be generally used between Local/ Group JBs and the main cable trays and the same shall be furnished and installed by the Bidder. It is the assembly of sections and associated fittings forming a rigid structural system used to support the cable from the equipment or instrument enclosure up to the main cable trays (trunk route).

5.04 The covers on the cable sub-trays shall be used for protection of cables in areas where damage may occur from falling objects, welding spark, corrosive environment, etc. & shall be electrically continuous and solidly grounded. The cable trays shall not have sharp edges, burrs or projections injurious to the insulation or outer sheath of the cables.

5.05 The supporting arrangement of cable tray system shall be able to withstand the weight of the cable and cable tray system. The supporting interval shall not be more than the recommended span for the above loading for the type of cable tray selected. The tray shall not overhang by more than one meter from the support at the dead end. As far as practicable the cable sub-tray system shall be supported from one side only, in order to facilitate installation and maintenance of cables.

5.06 **Pipe size & type**
Shall be Suitable with 40% fill criteria.GI conduits shall be of heavy duty confirming to IS: 9537.

5.07 **Cable lugs and ferrules**
Lugs and ferrules for aluminium Bidder cables shall be aluminium solder less crimping type. Copper cable lug/ ferrule shall be solder less tinned copper crimping type.
5.08 Cable clamping

All cables laid on trays shall be neatly dressed up & suitably clamped/tied to the tray. For cables in trefoil formation, trefoil clamps shall be provided.

ANNEXURE – ECI- 11

2.8 COMMISSIONING SPARES (To be supplied in addition to the sensor/reagent supplied along with instrument)

The following items shall be considered as commissioning spares.

a) pH Sensor - 1 No
b) Silica Reagents – 1 set