



SPECIFICATION FOR
DEMINERALISATION SYSTEM
(SAC, SBA & MB)

SPEC. No.: ROS 6162

REV: 00

BHARAT HEAVY ELECTRICALS LIMITED,
RANIPET- 632 406.

TECHNICAL SPECIFICATION

For

DEMINERALISATION PLANT
(SAC, SBA & MB)

00	16.06.17	<i>A. Kumar</i> ABH	<i>A. Kumar</i> ABH	<i>H. Manish</i> SM 200617	Fresh issue
Rev.No	Date	Prepared	Checked	Approved	Remarks

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SECTION - 1.0 : SCOPE OF SUPPLY

1.1 The intent of this specification is to cover Design, Engineering, Manufacturing, shop testing, supply, erection & commissioning, performance guarantee test and handing over of the Units mentioned below.

- **DE-GASSER SYSTEM**
- **DM PLANT (SAC, SBA & MB) SYSTEM**

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

- a. 2 x 100% (1W+1S) Degasser towers with accessories
- b. 4 x 100% (2W+2S) Degasser Blowers with drive motors & accessories
- c. 3 x 50% (2W+1S) RO stage-II permeate supply pumps with drive motors and all accessories.
- d. 2 x 50% (2W) strong acid Cation (SAC) Exchanger units with all accessories, resins, internals, frontal piping etc.
- e. 2 x 50% (2W) strong basic Anion (SBA) Exchanger units with all accessories, resins, internals, frontal piping etc.
- f. 3 x 50% (2W+1S) Mixed Bed (MB) Units along with all accessories, internals, resins, frontal piping etc.
- g. 2 x 100% (1W+1S) Mixed Bed Air Blowers with drive motors and all accessories for regeneration
- h. 2 x 100% (1W+1S) DM regeneration pumps with drive motors and all accessories.
- i. 1 x 100% (1W) Acid measuring tank (AMT) & accessories
[for SAC regeneration]
- j. 1 x 100% (1W) Acid measuring tank (AMT) & accessories
[for MB regeneration]
- k. 2 x 100% (2W) Acid dosing ejectors & acc.
- l. 1 x 100% (1W) Caustic measuring tank (CMT) & accessories
[for SBA regeneration]
- m. 1 x 100% (1W) Caustic measuring tank (CMT) & accessories
[for MB regeneration]
- n. 2 x 100% (2W) caustic dosing ejectors & acc.
- o. 1 set of Valves as per enclosed P & ID
- p. 1 set of interconnecting piping/ducting system including valves and accessories etc. for the following areas as per the **enclosed P & ID**.
 - Degasser system to RO stage-II permeate tank
 - Degasser blowers to degasser(ducting)
 - Suction & discharge piping for RO stage-II permeate supply pumps

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- RO stage-II permeate supply pumps to SAC vessels
- SAC vessels to SBA vessels
- SBA vessels to MB vessels
- By pass piping from RO stage-II permeate supply pumps to MB vessels
- MB blowers to MB vessel
- DM regeneration pumps suction piping from DM Water storage tank upto pumps and recirculation line to DM water storage tank.
- DM regeneration pumps discharge to DM system
- Piping from bulk chemical storage system to AMT/CDT
- AMT/CDT area to DM system.
- MB outlet piping from vessel to outside of RO-DM plant building.
- q. 1 set of applicable foundation bolts, fasteners, safety shower – 2 nos, gaskets, supports, ladder, platforms and miscellaneous items etc.
- r. Electrical, Controls & Instrumentation as per specification / P&ID.
- s. 1 set of Electrical, Controls & Instrumentation as per specification & PID & ROS: 4160
- t. 1 set of Commissioning spares
- u. 1 set of mandatory spares as per Annexure.

The permeate water from RO stage-II shall be degasified in the Degasser and stored in a RO stage-II permeate tank (not in bidder's scope). The degassed water shall be pumped to the DM Plant (SAC, SBA & MB) to meet the boiler make-up water quality through RO stage-II permeate supply pumps. Necessary regeneration system shall be included in the DM system package for regeneration of DM resins as per specification. **Bulk storage tank /chemicals are excluded from the bidder's scope.** The P&ID, Legend & Layout for the DM system are enclosed along with this specification for reference.

- 1.2 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.**
- 1.3** 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.
- 1.4** General terms & conditions, instructions to the tenderer & other attachments referred to elsewhere are also part of this specification.

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1.5 The order of priority of this specification is as follows.

- a. Equipment Specification,
- b. Scheme drawing
- c. General design requirements

1.6 Resin supply packing shall be made in **drums (leak proof)** only. Resin supply in HDPE bag is not acceptable.

1.7 The material shall be dispatched to site as per the bidder's shipping list approved by BHEL. The format for the shipping list & quality plan will be given by BHEL after ordering for the successful bidder. All the items shall be dispatched as per the instructions provided by the customer.

1.8 Vendor to submit the commercial offer for complete package with break 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, DM system, DM Regeneration System, along with associated pipes & valves, with providing necessary supports, stage clearance, testing, commissioning, trial run & performance guarantee test and handing over of the entire system.

SECTION - 2.0 : PROJECT INFORMATION

- | | | | |
|-----|-------------------------|---|---|
| 2.1 | Owner | : | Tamil Nadu Generation and Distribution Corporation Limited. |
| 2.2 | Project Title | : | Ennore, SEZ- 2 x 660 MW |
| 2.3 | Location | : | Vayalur Village, Chennai – 120. |
| 2.4 | Nearest Railway Station | : | Athipattu Pudunagar (approx 5 kms) |
| 2.5 | Nearest Road | : | 5 KM road from Pattamandiri to Site on Thiruvottiyur – Ponneri district highway |
| 2.6 | Nearest port | : | Kamarajar Port Ltd. (Formerly Ennore Port Ltd.) |

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Site office/ Location

Site In charge / PSSR
Bharat Heavy Electricals Ltd,
C/o TANGEDCO, Ennore SEZ- 2x660 MW,
Vayalur Village, Chennai -120.
Tamil Nadu, India

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SECTION - 3.0 : TECHNICAL REQUIREMENT

3.1 DM PLANT CAPACITY

DM Plant 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 110 cu.m/hr** on continuous operation basis between regeneration of SAC & SBA and Mixed Bed

The capacity and the number of streams of the DM Plant (SAC+SBA+MB) is as follows.

a.	Total output capacity (Net) of DM plant	: 110 m ³ / Hr.
b.	Net output capacity of DM per stream	: 55 m ³ / Hr
c.	No. of streams of SAC	: 2W
	Net output between regeneration of each SAC cycle time / OBR	: 20 hours / 1100 m ³
d.	No. of streams of SBA	: 2W
	Net output between regeneration of each SBA cycle time / OBR	: 20 hours / 1100 m ³
e.	No. of streams of MB	: 2W +1S
	Net output between regeneration of each MB cycle time / OBR	: 140 hours / 7700 m ³

Note: The MB shall be designed to a maximum of 25 ppm in case of bypassing SAC & SBA. The MB shall be designed for maximum load condition and accordingly, the OBR shall be decided (subject to BHEL's approval).

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3.2 INLET WATER QUALITY FOR DESIGN OF DM SYSTEM

The inlet water quality (RO stage-II Permeate) to be considered for DM Plant design is as follows:

RO PERMEATE QUALITY

Sl.No	Parameters	Unit	Design
1	pH		5.0 to 6.0
2	Conductivity	μS./cm	50
3	Total dissolved Solids	mg/l	25.0
4	Temperature	deg C	25 – 35
5	Carbon di Oxide as CO ₂ - Design (after degasser)	ppm	5**
6	SiO ₂ as SiO ₂	ppm	0.8
7	Sodium as Na	ppm	8.0
8	Potassium as K	ppm	1.0
9	Calcium as Ca	ppm	0.3
10	Magnesium as Mg	ppm	0.1
11	Bicarbonate as HCO ₃	ppm	3.0
12	Chloride as Cl	ppm	12.0
13	Sulphate as SO ₄	ppm	0.05
14	Nitrate as NO ₃	ppm	0.1
15	Fluoride as F	ppm	0.05

Note: ** The CO₂ value mentioned is for the RO Stage-II permeate. The additional CO₂ liberated in SAC to be added in the ionic load for SBA design since no degasser is envisaged between SAC & SBA.

For the design of degasser, the CO₂ present in the RO stage-II permeate water shall be considered (around 100 ppm).

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3.3 OUTLET WATER QUALITY:

The plant design should meet the outlet water quality as indicated below.

3.3.1 DEGASSER OUTLET WATER QUALITY (before SAC)

Sl.No	Description	Unit	Values
1	Carbon di Oxide as CO ₂	ppm	< 5.0 ppm at max. flow rate

3.3.2 MIXED BED OUTLET WATER QUALITY

Sl.No	Description	Unit	Values
1	pH		6.8 to 7.2
2	Conductivity at 25 deg C	μS/cm	≤ 0.1
3	SiO ₂ as SiO ₂	ppm	≤ 0.01

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SECTION - 4.0 : TECHNICAL SPECIFICATION - MECHANICAL

4.1 DESIGN CRITERIA

The DM Plant shall be of **automatic operation** (but in case of regeneration, initiation shall be done manually and sequence of operation shall be automatic). The RO-2 permeate water supplied shall be treated in Degasser System comprising of Degasser Towers and Degasser Blowers. The degassed water shall be collected in a RO stage-II permeate tank (not in bidder's scope). The degasser tower shall be mounted on a separate steel structure. The steel structure is excluded from bidder's scope.

As the feed water to the degasser shall be directly connected from the RO membrane permeate outlet-having limitations of back pressures (0.7 bar maximum), bidders have to **limit the degasser inlet elevation (height to be less than 3 meters)** as indicated in the equipment specification.

The Degassed water shall be pumped to DM Plant by RO stage-II permeate supply pumps. The DM Plant consists of SAC, SBA & MB 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 SAC, SBA & MB resins. It shall consist of regeneration pumps, MB blowers and a set of chemical tanks, ejectors and required accessories for acid and alkali to be drawn from bulk storage tank outlet (Bulk storage tanks are not in bidder's scope). The design shall take care of the collection of regeneration effluent, all drains routed through pipes outside of the plant at a common trench near the DM Plant.

Necessary piping, pneumatic and manual operated valves, instruments, controls & Interlocks shall be provided in the system for auto operation and also as per the typical scheme drawing enclosed along with this specification. Please refer the equipment layout attached with specification. The piping, impulse lines, cables to instruments, limit switches/ control interlocks and trays shall be routed /installed suitably to have easy accessibility and aesthetic look.

Interconnecting of piping and valves system to be provided to facilitate any one SAC output shall be a feed to other two train SBAs. Also any one SBA output shall be a feed to other three stream of Mixed Beds. Provision for additionally one bypass line with valve directly feed to MB system from RO stage-II permeate supply pumps has to be given as per P &ID.

The details of the equipment / system are elaborated in respective section of this specification.

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4.2 TERMINAL POINTS:

Scope and terminal point details are indicated in the enclosed P&ID drawing with this specification.

- a. Feed water will be supplied by the purchaser at the inlet of degasser tower inlet flange. The outlet water from degasser tower shall be connected to the inlet of RO-Stage-II permeate tank by bidder. The RO stage-II permeate storage tank is in the scope of BHEL.
- b. Outlet DM water from DM Plant shall be terminated by the bidder at 20 m distance outside the DM Plant building boundary(south side of the RO-DM plant as per the enclosed layout). **The required outlet pressure is 2.0 bar (g) at the outlet of MB.**
- c. The DM regeneration pumps installation location is away from DM Plant, at a distance of around ~200 m (please refer to enclosed preliminary layout for exact distance). Hence vendor to consider additional 1 bar (g) as extra head over and above the regeneration pump discharge head requirement. The preliminary layout is enclosed with this specification.
- d. One suction nozzle with flange, with flooded suction nozzle will be made available at 5 m distance from the regeneration pump suction (Near DM makeup Water pump house).

Necessary interconnection piping from suction / discharge of regeneration pumps, valves etc. for regeneration system of DM plant is in bidder's scope.
- e. Regeneration pump recirculation / bypass pipeline (SS 304) has to terminated at 2 nos. DM tank's nozzle flange at the elevation about 10 m and at the distance of 15 m from the DM makeup pump house.
- f. Required compressed air will be made available at one common point in the DM Plant building and further distribution is in bidder's scope.
- g. The required chemicals (HCl & NaOH) for regeneration from bulk storage will be made available at bulk chemical storage tanks nozzle and about 160 m distance (also refer to enclosed layout for exact distance). Further piping and valves from this terminal point shall be in the bidder's scope.
- h. Electrical power supply from the control panel will be provided by the purchaser at the motor terminal. Bidder to provide the list of driver rating along with bid.

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- i. For control & instrumentation terminal points please refer E C&I specification ROS 4160.

4.3 SPECIFICATIONS FOR MECHANICAL EQUIPMENT

4.3.1 DEGASSER TOWER

- | | | |
|----|---------------------------------------|---|
| a. | Application | : To reduce CARBON DI OXIDE level.
in the RO stage-II permeate water. |
| b. | Quantity | : 2 nos. (2 W) |
| c. | Operation | : Continuous. |
| d. | Installation | : Mounted on the top of structural platform
arrangement. |
| e. | Type | : Vertical tower type & forced draught. |
| f. | Inlet water flow for degasser | : 57 m³/hr (min) |
| g. | Air to water ratio | : 18 m³/m³ (min) |
| h. | Specific Velocity of water | : 60 m³/hr/m² (max) |
| i. | DGT air vent velocity | : 6 m/s (max) |
| j. | Shell thickness & Height | : 6.0 mm(min.) & 3.0 m (max) |
| k. | Effective bed depth (Packing height): | 2.0 m (min) |
| l. | Material of Construction- Tower | : IS-2062 Gr-A. |
| | -Pall Ring | : Polypropylene.(sufficient qty to meet the reqt) |
| | -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 3.3 for Maximum CO ₂ level |
| o. | Guaranteed Outlet water quality | : As per section 3.4 |
| p. | Design Code | : IS 803 |

4.3.2 DEGASSER BLOWER WITH MOTOR

- | | | |
|----|--------------------------------|--|
| a. | Application | : To supply air to each Degasser Tower |
| b. | Quantity | : 4 x 50 % (2 Working +2 Standby) -2 blowers
(1W+1S) for each degasser tower |
| c. | Operation | : Continuous |
| d. | Type | : Centrifugal, |
| e. | Installation | : outdoor (Bottom of degasser tower supporting
steel structure). |
| f. | Flow | : Bidder to Specify |
| g. | Head | : Bidder to Specify |
| h. | Accessories | : Suction air filter, base frame etc. |
| i. | MOC - blower casing & impeller | : CI IS 210 FG 260 or Equivalent |
| | - shaft & sleeve | : EN 8 /ASTM A 321 & ASTM A276 TP316 |

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j. Motor : As per Electrical Spec.

4.3.3 RO stage-II Permeate tank By purchaser – not in bidder's scope.

4.3.4 STRONG ACID CATION (SAC) UNIT

- | | | | |
|----|-----------------------------------|-----------------------------------|---|
| a. | Application | | : To generate the Boiler make-up water from degassed RO stage-II permeate water. |
| b. | Quantity | | : 2 Nos (2 W) |
| c. | Type | | : Vertical, Cylindrical |
| d. | Feed water quality | | : Degassed water outlet quality in section 3.3 |
| e. | Effluent Outlet quality | | : bidder to specify. |
| f. | Net guaranteed output, | m ³ /hr | : 55-+ regeneration requirement |
| g. | OBR | m ³ | : 1100 between two successive regeneration + regeneration requirement of DM Plant. |
| h. | Continuous Operating hours | hrs | : 20 (between two successive regeneration) |
| i. | Regeneration | | : Counter Current |
| j. | Regeneration time | hrs | : 2 (max) |
| k. | Material -shell | | : IS - 2062 Gr-B |
| | Dished end | | : IS-2002 Gr.2A/SA 515Gr.70 |
| l. | Internal protection | | : 4.5mm thk Rubber lining in 3 layers as per IS 4682 Part- I & shore hardness 65 ± 5 ⁰ |
| m. | Design Code | | : IS 2825 |
| n. | Design Pressure | | : 6 bar (g) minimum. |
| o. | Test Pressure | | : 1.5 times of Design Pressure |
| p. | Vessel dia | m | : Bidder to decide |
| q. | Resin bed height | | : Minimum 1.5 m for cation resin, However, bidder to select increased resin bed height if required to meet the design ionic load |
| r. | Surface flow rate | m ³ /hr/m ² | : 40 (max.) |
| s. | Free Board | | : 100% of bed height |
| t. | Acid available for regeneration | | : ~ 30% HCl as per IS 265 |
| u. | Cation Resin life | | : 5 years minimum |
| v. | Attrition loss of resins | | : 3% per annum (max) |
| w. | Resin type - Cation | | : High capacity premium grade microporous strongly acidic, sulphonated polystyrene base, Cation exchange resins. |
| x. | Resin make | | : ROHM & HASS / BAYER / PUROLITE / DOW/ Equivalent (subject to BHEL's approval) |
| y. | Built in support Legs for vessel: | | |

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Quantity	:	4 nos.
Size	:	Minimum 200 NB pipe, CS, Sch 80 pipe with necessary gusset plates for strength.
Base Plate Size mm	:	~ 350 x 350 x 20 (L x B x thick)
z. Thinning allowance for dished ends	:	2.0 mm
aa. Corrosion allowance for shell & dish end	:	1.5 mm
ab: Fasteners	:	SS 316 all vessel internals, manhole & sight glass.
ac. 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.
ad. Accessories	:	Necessary Resin traps for SAC outlet and rinse water outlet (necessary internal nozzle shall be provided for mounting the resin trap), resin removal nozzles (dia 100 NB), distributor nozzles, inlet / outlet / regeneration nozzles, drain, vent, necessary sight glass (2 nos) 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 (2nos) davit type manholes (dia 500 mm size minimum) davit type at top and an access below the bed plate (ie. strainer on plate) etc.

4.3.5 STRONG BASE ANION UNIT

a. Application	:	To generate the Boiler make-up water from degassed RO Permeate water.
b. Quantity	:	2 Nos (2 W)
c. Type	:	Vertical, Cylindrical
d. Effluent Outlet quality	:	bidder to indicate
e. Net guaranteed output, m3/hr	:	55+ regeneration requirement
f. OBR m3	:	1100 between two successive regeneration + regeneration requirement of DM Plant.
g. Continuous Operating hours hrs	:	20 (between two successive regeneration)
h. Regeneration	:	Counter current
i. Regeneration time hrs	:	2 (max)
j. Material -shell	:	IS - 2062 Gr-B

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k.	Dished end		: IS-2002 Gr.2A/SA 515Gr.70
	Internal protection		: 4.5mm thk Rubber lining in 3 layers as per IS 4682 Part- I & shore hardness 65 ± 5^0
l.	Design Code		: IS 2825
m.	Design Pressure		: 6 bar (g) minimum.
n.	Test Pressure		: 1.5 times of Design Pressure
o.	Vessel dia	m	: bidder to decide
p.	Resin bed height		: Minimum 1.5 m for Anion resin, However bidder to select increased resin bed Ht. if required to meet the design ionic load.
q.	Surface flow rate	m ³ /hr/m ²	: 40 (max)
r.	Free Board		: 100% of bed height
s.	Alkali available for regeneration		: 48% NaOH as per IS 252
t.	Resin life		: Minimum 3 years
u.	Attrition loss of resins		: 5% per annum (max)
v.	Resin type - Anion		: Strongly basic polystyrene base high capacity macroporous type-I anion exchange resins. The anion resin shall be able to withstand a temperature of 60 deg C . Type II resin shall not be accepted.
w.	Resin make		: ROHM & HASS/ BAYER/ PUROLITE/ DOW/ Equivalent(subject to BHEL's approval)
x.	Built in support Legs for vessel:		
	Quantity		: 4 nos
	Size		: Minimum 200 NB pipe, CS, Sch 80 pipe with necessary gusset plates for strength.
	Base Plate Size	mm	: ~ 350 x 350 x 20 (L x B x thick)
y.	Thin. allowance for dished ends		: 2.0 mm
z.	Corrosion allowance for shell & dish end		: 1.5 mm
aa.	Fasteners		: SS 316 for all vessel internals, manhole & sight glass.
ab.	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.
ac.	Accessories		: Necessary Resin traps for SBA outlet and rinse water outlet (necessary internal nozzle shall be provided for mounting the resin trap), resin removal nozzles (dia 100 NB), distributor nozzles, inlet / outlet / regeneration nozzles, drain, vent, necessary sight glass (2 nos) of clear width not less than 75 mm for viewing resin level, pneumatic operated

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valves for automatic operation / regeneration, access ladder with safety cage, handrails at vessel top, two (2nos) davit type manholes (dia 500 mm size minimum) davit type at top and an access below the bed plate (ie. strainer on plate) etc.

4.3.6 MIXED BED UNIT

- | | | | |
|---|-----------------------------------|----------|--|
| a. | Application | : | To generate the Boiler make-up water from degassed RO Permeate water. |
| b. | Quantity | : | 3 nos. (2 Working + 1 stand by) |
| c. | Type | : | Vertical, Cylindrical |
| e. | MB Outlet quality | : | As per Section – 3.4 |
| f. | Net guaranteed output, | m3/hr | 55 + regeneration requirement per vessel |
| g. | OBR | m3 | 7700 between two successive regeneration + regeneration requirement of DM Plant. |
| h. | Continuous Operating hours | hrs | 140 (between two successive regeneration) |
| i. | Regeneration time | hrs | 4 (max) |
| j. | Material- shell | : | IS - 2062 Gr-B |
| k. | Internal protection | : | Rubber lining 4.5 mm thick 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 | : Bidder to decide |
| p. | Resin bed height | : | Minimum 0.5 m for cation resin, minimum 1.0 m for Anion resin.
Or the minimum indicated in respective resin literature, whichever is higher shall be considered. However bidder to select increased resin bed height if required to meet the design ionic load. |
| <p>Inert resin of height around 200 mm shall be provided to meet the regeneration requirement.</p> | | | |
| q. | Surface flow rate | m3/hr/m2 | : 60(max) |
| r. | Free Board | : | 100% of bed height |
| s. | Acid available for regeneration | : | ~ 30% HCl as per IS 265 |
| t. | Alkali available for regeneration | : | ~ 48% NaOH as per IS 252 |
| u. | Resin life | : | Minimum 3 years for Anion resin & minimum 5 years for Cation resin. |
| v. | Attrition loss of resins | : | 3% per annum (max) for Cation |

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4.3.7 MIXED BED BLOWER WITH MOTOR

- | | | |
|----|--------------------------------|--|
| a. | Application | : To supply air to MB during regeneration. |
| b. | Quantity | : 2 Nos (1 W + 1S) |
| c. | Operation | : Intermittent |
| d. | Installation | : Indoor near Mixed Bed |
| e. | Type | : Twin Lobe |
| f. | Flow | : to meet process requirement |
| g. | Head | : to meet process requirement (min. 5-9 PSI) |
| h. | MOC – blower casing & impeller | : CI IS 210 FG 260 or Equivalent |
| | - shaft & sleeve | : EN 8 /ASTM A 321 & ASTM A276 TP316 |
| i. | Motor | : As per Electrical Spec. |
| j. | Accessories | : Silencers, Non-return valve, Pulleys with V-Belts & guard, Base frame, Pr. Relief valve, Suction filter, pressure gauge, anti-vibration Mountings and flexible discharge connection Acoustic hood etc. |

4.3.8 RO stage-II PERMEATE SUPPLY PUMPS WITH MOTOR

- | | | |
|----|----------------------------|---|
| a. | Application | : To feed water to D M plant |
| b. | Quantity | : 3 Nos (2 W + 1S) |
| c. | Operation | : Continuous |
| d. | Installation | : Indoor |
| e. | Type | : Centrifugal, Horizontal |
| f. | Suction | : From RO-II permeate Water storage tank |
| g. | Discharge Flow rate ,m3/hr | : Bidder to select with 10% margin (min. 63 M ³ /hr) |
| h. | Discharge head, mWC | : Bidder to select with minimum head required. The head requirement to be calculated by considering all losses for pump duty flow in the MB system plus 2 bar (g) pressure at MB final outlet terminal point (min. 4.5 kg/cm ²). |
| i. | Speed, rpm | : 1450 (max) |
| j. | Shaft Seal | : Mechanical – API plan 11 |
| k. | MOC of all wetted parts | : |
| | Casing | : SS316 |
| | Impeller | : SS316 |
| | Shaft | : SS410 |
| | Shaft sleeves | : SS316 |
| l. | Coupling | : SS316 Flexible coupling (Spacer type) with Guard |
| m. | Base frame for Pump & | : Carbon steel with epoxy coated. |

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- Motor mounting
- n. Bearing : Anti-friction
- o. All fasteners : Stainless Steel 316
- p. Motor : As per Electrical Spec. (TEFC, outdoor type, Class “B” insulation IPW-55.

4.3.9 SAC, SBA & MB(DM) REGENERATION PUMPS

- a. Application : To supply DM water from DM water storage tank to DM system
- b. Quantity : **2 Nos (1 W + 1S)**
- c. Operation : Intermittent
- d. Installation : Indoor
- e. Type : Centrifugal, Horizontal
- f. Suction : From D.M. Water storage tank
- g. Discharge Flow rate, m3/hr : Bidder to select with 10% margin
- h. Discharge head, mWC : Bidder to select with minimum head required. (The head requirement to be calculated by considering all losses in the DM system plus frictional loss of pipe segments or 1 bar(g), whichever is high, at DM inlet terminal point. The pipe line (SS) from the pump common discharge to the DM location shall be taken care: Min.4 kg/cm²).
- i. Speed, rpm : **1450 (max)**
- j. Shaft Seal : Mechanical – API plan 11
- k. MOC of all wetted parts :
 - Casing : SS316
 - Impeller : SS316
 - Shaft : SS410
 - Shaft sleeves : SS316
- l. Coupling : SS316 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 : Stainless Steel 316
- p. Motor : As per Electrical Spec. (TEFC, outdoor type, Class “ B” insulation IPW-55.

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4.3.10 SAC, SBA REGENERATION SYSTEM : Tank & accessories

a.	Tanks	: Acid measuring Tank (AMT)	Caustic measuring Tank (CDT)
	Quantity	: 1no.	1no.
	MOC	: IS 2062	IS 2062
	Tank thickness	: 6.0 mm (min)	6.0 mm (min)
	Tank capacity	: 120% of chemical Requirement for One regeneration	120% of chemical Requirement for One regeneration
	Agitator, SS, slow speed	: NA	1 no per tank
	Internal protection	: 4.5mm thk Rubber Lining as per IS 4682	4.5mm thk Rubber Lining as per IS 4682
b.	Accessories	: Ejectors, piping, valves, mixers & safety showers, Breather (fume absorber) for each Acid measuring Tank & CO2 absorber for each Caustic Dilution tank etc.	

4.3.11 MB REGENERATION SYSTEM: Tank & accessories

a.	Tanks	: Acid measuring Tank (AMT)	Caustic measuring Tank (CDT)
	Quantity	: 1no.	1no.
	MOC	: IS 2062	IS 2062
	Tank thickness	: 6.0 mm (min)	6.0 mm (min)
	Tank capacity	: 120% of chemical Requirement for One regeneration	120% of chemical Requirement for One regeneration
	Agitator, SS, slow speed	: NA	1 no per tank
	Internal protection	: 4.5mm thk Rubber Lining as per IS 4682	4.5mm thk Rubber Lining as per IS 4682
b.	Accessories	: Ejectors, piping, valves, mixers & safety showers, Breather (fume absorber) for each Acid measuring Tank & CO2 absorber for each Caustic Dilution tank etc.	

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4.3.12 PIPING AND VALVES

All piping and valves shall be as per the spec. detailed in general design requirements of Sec.4.5 & 4.6. Also refer the typical P&I D drawing / scheme enclosed.

4.4 GENERAL DESIGN REQUIREMENTS

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

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 equipment's noise level shall be < 85dBA 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 equipment.
5. All carbon steel pipelines unless otherwise specified elsewhere-carrying corrosive fluids should be rubber lined 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** unless specified.
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.

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12. All valves and piping shall be supported suitably with cushion / rubber sheet and bolted with “U” clamps. The supporting truss must have minimum width of 1.5 time of the pipe diameter and base plate of thick of 12 mm (minimum).
13. Supports for all equipment and platforms, walkways, stairways for access to all equipment shall be provided as required.
14. A platform of 800mm width interlinking all vessels with ladder shall be provided. The stair case & platform shall have handrails for safe climbing and access.
15. All platforms and stairways shall have minimum clear width of 1000 mm. All platforms, stairways, landings etc. shall have railings and guards.
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 of SS 304 for entire DM Plant system.
19. Vessel Internal supporting cleats shall be of SS-316.
20. The direction of Flow shall be indicated by an arrow at regular intervals on all pipelines.
21. All the equipment & parts shall be tagged with corresponding KKS numbering.
22. Name all vessel, 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 shall be provided with additional nozzles 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 in bidder's scope
25. For the calculation of resin volume in all ion exchange units, ion exchange vessels sizing etc. 10% (ten percent) deration on corrected exchange capacity, as obtained from characteristic curves, shall be considered to provide margin towards ageing of resins.

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26. Bearings for the Pumps/Blowers shall be of SKF/FAG make only.

4.4.2 TANKS

All tanks except those specified otherwise shall be made of steel. 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. The tank shall be provided with suitably supporting legs, inlet and outlet connections, hand hole, manholes, connections for level gauges, vents, drains, overflow, access ladder with safety cage, 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 hinged type top covers in two halves and level indicators to indicate the level.

Design of pressure vessels shall conform to IS 2825 and atmospheric tanks shall conform to the requirements of IS-803. All the nozzles shall be provided with necessary valves for open /close/ regeneration operation. All the vessels nozzles shall be fitted with leak proof dummy flanges before dispatch. All the manhole doors shall be provided with davit arrangement.

4.4.3 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 in case 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. Vibration level must be with in satisfactory zone as per **ISO 10816-3:1998(E)** for machine group: **3** standards for rigid supported base with zone boundary

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6. Tolerance in pump guaranteed efficiency and rated head for the rated flow shall be minus 2% to plus 3%.
7. Pressure gauges shall be provided on discharge side of all pumps.
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.

4.4.4 DEMINERALISING SYSTEM:

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

1. DM Plant 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 MB 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/ windows shall be of clear width not less than 75 mm, for viewing resin level, mounting legs, valves for automatic operation / regeneration of the system in the mixed 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 shall also furnish chemical calculations for regeneration of resins. The regeneration process shall be based on **self-neutralization**.

4.4.5 RESIN REGENERATION SYSTEM:

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

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grade / rayon grade. These chemicals will be drawn from Bulk storage tanks (Others scope)

2. The bidder shall include the required regeneration equipment's 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 at least one regeneration with **20%** margin. The tank shall be of MSRL with removable top covers and level indicators. Fume absorbers shall be provided for these tanks.
4. Caustic / Alkali measuring / dilution tank for the regeneration of anion exchanger shall be of sufficient capacity to store the quantity of alkali required for at least one regeneration with **20%** margin. The tank shall be of MSRL with removable top covers and level indicators to indicate the level. **Suitable agitator shall be provided to diluting 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. Density indicators, Flow orifice board / plate shall also be provided.
6. Safety showers, meeting IS specification, shall be provided in the acid & alkali handling area.
7. All header pipes shall be sized considering simultaneous operations of all working chains at rated condition.
8. Suitable density indicators shall be provided to determine the exact strength of the acid / alkali injected and flow rate to the exchanger.
9. 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.

4.4.5.2 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:
2. 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.

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

4.5 PIPING

4.5.1 LINE SIZING

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:

Velocity

Pump suction	≤150mm	1.2-1.5 m/s
	≥200mm	1.2-1.8 m/s
Pump discharge & recirculation	<50mm	1.2-1.8 m/s
	≤150mm	1.8-2.2 m/s
	≥200mm	2.1-2.5 m/s
Header	≤150mm	1.5-2.2 m/s
	≥200mm	2.1-2.4 m/s

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.

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.

Bidder shall provide suitable sampling points with SS316 valves to take water samples for testing purpose. The water samples shall be through 20 m NB dia pipes of SS 316.

All high points in piping system shall be provided with vents along with valve. All low points shall be provided with drain along with drain valve.

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

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.

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

4.5.2 MATERIALS OF CONSTRUCTION

SL. NO.	SERVICE	SIZE	PIPES	FITTINGS	FLANGES	GASKETS	LINE JOINT
1.1	DEMINERALISED WATER	NB 65MM & ABOVE	Gr. SS304 SCH.40	Gr. SS304 SCH.40	ASTM A105	EPDM / NITRILE RUBBER	FLANGED
		NB 50MM & BELOW	ASTM A312 TP 316	ASTM A403 Gr.WP 316/A 182-F316	ASTM A105 (Ref: Note-3)	EPDM / NITRILE RUBBER	SOCKET WELDED
1.2	INSTRUMENT AIR SYSTEM	NB 50MM & BELOW	ASTM A53 GALVANISED IS 1239-heavy	ASTM A234 Gr. WPB GALVANISED	ASTM A105 GALVANISED	WIRE INSERTED RED RUBBER	SCREWED
1.3	CHEMICALS (HCL, NaOH & etc.)	ALL SIZES	c-PVC SCH. 80 OF ASTM (industrial grade)	c-PVC SCH. 80 OF ASTM (industrial grade)	c-PVC SCH. 80 OF ASTM (industrial grade)	EPDM / NITRILE RUBBER	FLANGED/ SCREWED
1.4	SAC, SBA & MB FRONTAL PIPING	ALL SIZES	c-PVC SCH. 40 OF ASTM (Industrial grade)	c-PVC SCH. 40 OF ASTM (Industrial grade)	c-PVC SCH. 40 OF ASTM (Industrial grade)	EPDM / NITRILE RUBBER	
1.5	DM SYSTEM FEED WATER PIPING	ALL SIZES	c-PVC SCH. 40 OF ASTM (Industrial grade)	c-PVC SCH. 40 OF ASTM (Industrial grade)	c-PVC SCH. 40 OF ASTM (Industrial grade)	EPDM / NITRILE RUBBER	

Notes

1. The material of DM water system piping from MB outlet to DM water storage tank shall be ASTM A 312 TP 304 SCH.40. Fittings shall be of SS 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.

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3. Blind flanges on SS Pipe lines shall be to ASTM A 240-TP 304. Stub ends shall be used at flanged connections.
4. Cast steel valves shall be provided for compressed air system.
5. Ball valves or Plug valves shall be provided for oil and air system.
6. All branch connections shall be wrought or forged steel based on the size and availability based on ASTM Standards.
7. All piping from degasser tank out let to SAC/SBA/ MB vessels outlet including frontal piping shall be trial assembled and tested before dispatch.
8. All piping & valves supports shall be of dismantling type for easy maintenance using suitable bolted connections.
9. All non-metallic piping (uPVC / cPVC / HDPE) shall be industrial grade.

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 m above walkways and working areas and 7.5 m above roadways unless otherwise approved by the 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. At all the screwed valves and screwed connections on equipment, unions shall be provided to facilitate 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.

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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 code ASME B31.1.

4.5.6 INSPECTION & CLEANING

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

All hot bent, forged formed, fabricated and straight pipes shall be chemically cleaned, pickled or wire brushed 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 (if applicable)

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.

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4.6 VALVES

4.6.1 DESIGN AND CONSTRUCTION FEATURES

The following consideration shall be made during the design / selection of valves for the DM Plant.

1. For the DM 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.
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 & regeneration of the plant.
6. The painting shall be as per the requirements indicated in the painting Section of this specification.
7. The check valves shall be of wafer type swing check valve suitable for mounting between flanges.
8. The Material of Construction of the body and disc of check valve shall be SS 316.
9. Bidder shall furnish the valves schedule in the attached **Annexure-6**

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4.6.2 VALVE – MATERIALS

SL NO.	SERVICE	SIZE	BODY/ BONNET	DIAPH RAGM / DISC / BALL	STEM / SHAFT	HAND WHEEL	VALVE ENDS
2.1	DM WATER & DG WATER	>65NB	IS 210 FG 200 Rubber lined DIAPHRAGM VALVE	EPDM		ASTM A47 Gr 32510	FLANGED #150PSI
		< 50 NB	ASTM A312 TP 316			ASTM A47 Gr.32510	SOCKET WELDED
2.2	DM WATER & DG WATER Pumps suction & delivery	>65NB	IS 210 FG 200 Rubber lined Butterfly Valve	SS 316	SS 410	ASTM A47 Gr 32510	FLANGED #150PSI
		< 50 NB	ASTM A312 TP 316			ASTM A47 Gr.32510	SOCKET WELDED
2.3	INSTRUMENT AIR SYSTEM (BALL VALVES)	< 50 NB	ASTM B 62/ IS: 318 Gr 2	ASTM B 62 / IS: 318 Gr2	ASTM B 62 Gr A / IS: 320 HT 2	ASTM A47 Gr 32510	SCREW TYPE
2.4	CHEMICALS	ALL SIZE	CPVC ASTM D1784 PN 16 Pressure rating	EPDM		POLYPROP YLENE	FLANGED / SOCKET

- NOTE : 1 Testing of body, seat and back 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. The material of DM water system Valve from MB outlet to DM water storage tank shall be stainless steel to A 351 CF8M instead of CS (rubber lined). Also Gate/Globe valve shall be used instead of Butter fly valve. Valve shall be with butt welded ends instead of flanged ends.

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4.7 PAINTING: Please refer to Annexure-A.

4.8. VENDOR LIST FOR MECHANICAL ITEMS: Please refer to Annexure-B

However, the following makes must be considered for items indicated below.

1. Pump Mech seal : John crane / Durametallic / Eagle Burgmann / Flowserve sanmar
2. Pump Bearing : SKF /FAG
3. Blowers : Everest / Kay international/ RKR / Hick Hargrives

SECTION - 5.0 : ELECTRICAL, CONTROLS & INSTRUMENTATION

Refer ROS 4160 for the E, C&I portion of the DM Plant system.

SECTION - 6.0 :TECHNICAL DETAILS FOR CIVIL WORKS

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

The approximate area of the DM building is indicated in the enclosed drawing. Detailed construction drawing with foundation requirement like load details, foundation pockets etc, for all the equipment including tanks, flooring requirements, trenches for pipe routing, cable routing & drains 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 DM Plant boundary.

Foundation bolts, nuts & washers for all equipment shall be supplied by the bidder as per their offered equipment requirement. The approximate area & location are indicated in the enclosed lay out drawing. Bidder to accommodate the DM system with in the stipulated area only as indicated in the typical layout drawing attached.

SECTION - 7.0 : PERFORMANCE GUARANTEE

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

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7.1 PERFORMANCE GUARANTEE

7.1.1 The bidder shall guarantee all equipment 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.

7.1.2 Performance test shall be conducted for each set of DM stream along with degasser tower. The guarantee tests shall cover the following but not be limited to the rated parameters for smooth operation of complete DM system:

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

Minimum 3 performance test run shall be conducted 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) for each stream.

7.1.3 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 equipment's supplied shall be guaranteed for a minimum period of 12 (twelve) months from the date of successful commissioning of the units. **Resins guarantee shall be as per spec. clause mentioned elsewhere in the specification.**

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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 whichever is later.

SECTION - 8.0 : SPARES

8.1 COMMISSIONING SPARES:

The bidder shall provide commissioning spares, mandatory spares and the recommended spares for 3-year O&M operation. The commissioning spares, mandatory spares shall be delivered along with the main supply well in time before the start-up & commissioning of the plant. The commissioning spares and 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. The price for the commissioning spares shall be included in the main supply and the list shall be provided along with the bid, this price will be included for bid evaluation. Any unutilized commissioning spares shall be handed over to the Owner.

List of commissioning spares.

Sl. No.	Description of the equipment	Description of spares	Qty	Remarks
01	RO Stage-II permeate supply pumps DM regeneration pumps	'O' rings and gaskets	1 set	For each type of pump
02	Mixed Bed Blower	V Belts Filter elements Seals	1 set 2 set 1 set	For each blower
03	Valves	Gland packing	01 set per valve	for each size and type
		Gasket for valve Bonnet / Cover	01 set for every set of 4 valve	For each size & type
04	Butterfly / diaphragm valves	Bearing Body seat / Disc seal ring	1 set 1 set	For each size & type

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Sl. No.	Description of the equipment	Description of spares	Qty	Remarks
		Seal retaining ring Diaphragm	1set 1 set	
05	DM System(for each vessel)	Strainers (Filter Nozzle) for collector & distributer	10 %	For each size & type
06		Ejector for Acid & Alkali injection	2 sets	
07		Sight Glass (toughened)	3 nos	

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8.2 MANDATORY SPARES – MECHANICAL

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

Sl. no.	Description of the equipment	Description of spares	Qty	Remarks
1	FOR EACH TYPE OF UNITED AND HORIZONTAL PUMPS. i). DM Feed Pump ii). DM Regeneration pump	a. Bearing	1 Set	For each type and size of pump
		b. Gland packing	1 ½ kg	
		c. Shaft Sleeve	1 Set	
		d. Impeller with shaft	1 Set	
		e. Mechanical Seal	1 Set	
2	MEDIA	a. Cation Resin	10% of total quantity filled initially.	
		b. Anion Resin	10% of total quantity filled initially.	
		c. Rasching Rings	10% of total quantity filled initially.	
3	VESSEL INTERNAL FITTINGS	Internal fittings	1 Set for each type of exchange /fitter	
4	EJECTOR FOR AMT & CDT	Ejector	1 Set for each type	
5	CIRL DIAPHRAGM VALVE	a. Complete Valve	2 nos. each type & size.	
		b. Diaphragm	5 nos. each of different sizes of valve	
		c. Valve Spindle	2 nos. each of different sizes of valve	

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Sl. no.	Description of the equipment	Description of spares	Qty	Remarks
6	OTHER TYPE VALVE (Except Control valve)	a. Complete valve	2 nos. each of different size of valve in the system	
		b. Sampling & needle valve	4 nos. each type & size	
7	NON-RETURN VALVE	a. Body Seat ring	2 nos. for each size valve.	
		b. Flap rings	2 nos. for each size valve.	
8	MOTORS	Motor -bearings	1 set each for drive end and Non drive end.	
9	CONDUCTIVITY INSTRUMENT	a. Complete meter	1 no. for each size.	
		b. Neon Lamp	2 nos. for each size	
		c. Power supply card	1 no. for each size	
		d. Controller PCB	1 no. for each size	
		e. Transformer	1 no. for each size	
		f. Relay	1 no. for each size	
		g. Meter Movement	1 no. for each size	
		h. Cell	1 no. for each size	

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Sl. no	Description of the equipment	Description of spares	Qty	Remarks
10	pH INSTRUMENT	a. Complete meter with cell & accessories	1 no. for each size.	
		b. Neon Lamp	8 nos. for each size	
		c. Power supply card	1 no. for each size	
		d. Amplifier PCB	1 no. for each size	
		e. Controller PCB	1 no. for each size	
		f. Transformer	1 no. for each size	
		g. Relay	1 no. for each size	
		h. Meter Movement	1 no. for each size	
		i. Electrodes Assembly	1 no. for each size.	
11	LEVEL GAUGE	a. Glass tube	5 nos. for each size.	
		b. offset Valve	2 nos. for each size.	
12	LEVEL SWITCH (Side mounted)	a. Float & rod	1 no. for each size	
		b. Switch assembly	1 no. for each size	
		c. Magnet	1 no. for each size	
13	MAINTENANCE SPARES	a. Pr. Gauge	2 nos. for each size	
		b. Flow Indicator (By pass / on line type)	2 nos. for each size	
		c. Float	2 nos. for each size	
		d. Meter tube	1 no. for each size	
		e. Gaskets	3 nos. for each size	

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MANDATORY SPARES - ELECTRICAL, CONTROLS & INSTRUMENTATION-Refer ROS 4160

8.3 RECOMMENDED SPARES FOR 3 YEARS O&M (Mechanical)

In addition to this bidder to provide the 3 years recommended O&M spares list with price separately along with the bid. The purchaser reserves the right to buy any of the recommended spares as considered necessary by him during later stage. The price of recommended spares **will not be considered for bid evaluation.**

The prices of recommended spares shall be consistent with those of the mandatory spares

SECTION - 9.0 : ERECTION , COMMISSIONING, TRIAL OPERATION, PG TEST & HANDING OVER:

Refer Section 9 containing the erection, commissioning, trial operation, Performance Guarantee (PG) test and handing over of the DM system is attached separately along with this spec.(ROS 6154).

SECTION - 10.0 : DOCUMENTATION:

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

1. All documents and drawing 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 manual, O&M manual etc., shall be submitted in bound folder in **seven copies.**
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

SECTION - 11.0 : DOCUMENTS 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.

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2. Duly filled up Data sheets enclosed - Annexures – 1 to 5
3. Technical write-up giving details of equipment, sequential operation, interlocks / control requirement.
4. Resin quantity calculations for SAC, SBA & MB along with resin literature and characteristic curves.
5. Resin regeneration calculations for SAC, SBA & MB.
6. Resin regeneration sequence for SAC, SBA & MB with flow rate, duration, effluent details etc.,
7. Process flow diagram
8. Preliminary P& I diagram
9. Preliminary Equipment layout drawing
10. Typical internal arrangement drawing for DGT, SAC, SBA & MB
11. Utility requirements like instrument air, service air and service water for regeneration and rinse etc.
12. Typical Quality Plan.
13. Preliminary civil requirements.
14. Preliminary 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 - 5. With cost of withdrawal if any.** If there is no deviation "NIL" statement shall be furnished. In the absence of the non-attachment of this **Annexure-5**, 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.

SECTION – 12.0 : DOCUMENTS TO BE SUBMITTED AFTER ORDER:

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

Phase – 1 within 3 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

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3. Process flow diagram
4. P and I Diagram including pipe sizes and terminal points.
5. Resin quantity calculations along with resin literature and characteristic curves.
6. Resin regeneration calculations and resin regeneration sequence with flow rate, duration, effluent details etc.,
7. Design calculation and thickness calculations for all major vessels and tanks as per code.
8. Generated regeneration water quantity / quality (TDS & pH and major constituents) of each regeneration
9. Duly filled Data sheets enclosed – Annexure 1 to 3
10. Equipment layout showing equipment details, headroom, size.
11. Technical Write-up and design basis
12. MB system “Control Description” write-up including sequential operation, controls, interlocks, protection, annunciation etc.
13. Quality Plan and field quality checks, stage inspection etc. for the above equipment's & system

Phase – 2 within 5 weeks from the date of purchase order receipt.

14. 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 pump & motor.
16. 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.
17. Performance curves for pumps & blowers
 - Flow Vs Head
 - Flow Vs efficiency
 - Flow Vs Power
 - Flow Vs NPSH
18. Duly filled Data sheets enclosed – Annexure 3 to 5
19. Un-priced purchase order copies of the equipment & accessories ordered on sub-vendors (The list of approved sub-vendors are given in section -----)
20. Detailed assembly & cross sectional drawing of valves.
21. Instrument schedule.
22. Detailed PLC I/O list

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

23. Isometric drawing of pipe segments.
24. Erection Manual indicating
Erection / installation instruction of equipment.
Log sheet containing Stage check parameters & clearance
Log sheet for Alignment Check of pump & motor
Field quality checks
25. Performance Test procedure
26. As-built manufacturing drawing of the equipment and total system with bill of materials (BOM)
27. All the documents called in Electrical specification.
28. Detailed bill of materials for all the items with make / detailed vendor name etc.
29. All the documents called in Electrical specification

12.1 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 guarantees 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. Test Certificates for all the supplied instruments.
10. List of alarm, interlock & trip set points
11. Installation drawings for instruments
12. Wiring drawings & GA drawings for Local Panels, junction boxes.
13. As built drawings

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

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SECTION – 13: ATTACHMENTS:

1. Erection, Commissioning PG Test & Handing Over Tech Spec. : ROS: 6154, Rev:00
2. RODM Equipment Layout Drawing No. : 1-WT-220-01054, Rev 00
3. P&ID for DM System Drawing No. : 1-WT-220-01053, Rev 00
4. Legend for P&ID Drawing No.: 2-WT-220-00149, Rev 01
5. Hook up Drawings: 3-WT-310-00580, 3-WT-310-00581, 3-WT-310-00582, 3-WT-310-00583, 3-WT-310-00584, 3-WT-310-00585, 3-WT-310-00586, 3-WT-310-00587, 3-WT-310-00588 and 3-WT-310-00589.
6. Painting Procedure : Annexure A
7. Vendor List : Annexure B

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BHEL Enquiry / P.O. Reference No. & Date:

Annexure-1

GUARANTEE DATA SHEET

I) DEGASSER OUTLET WATER QUALITY

Sl.No.	Description	Unit	Values
1	Carbon di Oxide as CO ₂	ppm	
2	Conductivity	μS/cm	
3	pH		

II) DM PLANT (MIXED BED) OUTLET WATER QUALITY

Sl.No.	Description	Unit	Values
1	pH		
2	Conductivity	μS/cm	
3	SiO ₂ as SiO ₂		
4	Sodium as Na	ppm	
4	TDS (including Na+SiO ₂)	ppm	
5	Organic matter as KMnO ₄ value	ppm	
6	Carbon di oxide	ppm	

III) SAC & SBA OUTPUT BETWEEN EACH REGENERATION FOR EACH STREAM

Sl.No.	Description	Unit	Values
1	NET	M ³	
2	GROSS	M ³	

IV) MB OUTPUT BETWEEN EACH REGENERATION FOR EACH STREAM

Sl.No.	Description	Unit	Values
1	NET	M ³	
2	GROSS	M ³	

V) CHEMICAL REQUIREMENT PER REGENERATION OF SAC & SBA INCLUDING NEUTRALISATION FOR EACH STREAM

Sl.No.	Description	Unit	Values
1	HCl - 30%	kg/regen	
2	NaOH - 48%	Kg/regen	

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VI) CHEMICAL REQUIREMENT PER REGENERATION OF MIXED BED INCLUDING NEUTRALIZATION FOR EACH STREAM

<i>Sl.No.</i>	<i>Description</i>	<i>Unit</i>	<i>Values</i>
1	HCl - 30%	kg/regen	
2	NaOH - 48%	Kg/regen	

VII) SAC RESIN FOR EACH STREAM

<i>Sl.No.</i>	<i>Description</i>	<i>Unit</i>	<i>Cation</i>
1	Quantity per vessel	Ltrs	
2	Life	Years	

VIII) SBA RESIN FOR EACH STREAM

<i>Sl.No.</i>	<i>Description</i>	<i>Unit</i>	<i>Anion</i>
1	Quantity per vessel	Ltrs	
2	Life	Years	

IX) MIXED BED RESIN FOR EACH STREAM

<i>Sl.No.</i>	<i>Description</i>	<i>Unit</i>	<i>Cation / Anion</i>
1	Quantity per vessel	Ltrs	/
2	Life	Years	/

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Annexure – 2

BHEL Enquiry / P.O. Reference No. & Date:

ELECTRICAL POWER CONSUMPTION

Sl. No.	Eqpt.. Description	Qty		Drive rating KW	Conn load. Load KW	Power consumption KW**	Voltage, Phase
		W	SB				
A	FOR CONTINUOUS OPERATING EQPT.						
1							
2							
3							
4							
5							
6							
7							
	Sub total of A						
B	FOR INTERMITTENT OPERATING EQPTS.						
1							
2							
3							
4							
5							
	Grand Total						

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

W – Working

SB – Standby

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Annexure - 3

EQUIPMENT DATA SHEET

1.0 DEGASSER SYSTEM

1.1 DEGASSER TOWER & ACC.

- a. Application : To reduce CO₂ level in the permeate
: water from R.O. Desalination Plant.
- b. Quantity : **TWO sets. (1W+1S)**
- c. Degassed water Tank : **Not in Bidder's scope**
Tower particulars
- d. Type :
- e. Make :
- f. Model :
- g. Flow rate in M³/hr - design/Max :
- h. Design Code :
- i. Corrosion allowance Shell mm :
- j. Material of Construction :
- k. Dia x Height mm :
- l Thickness Shell/Ends mm :
- m.. Surface Flow rate in m/sec-Design/Max:
- n. **Velocity** :
- o. **Air to water ratio** :
- p. Internal Protection :
- q. External protection :
- r. Design Pressure :
- s. Packing material of tower :
- t. Quantity of packing materials :
- u. Packing height :
- v. Inlet Nozzle size, type, rating :
- w. Outlet nozzle size, type, rating :
- x. Level switches :
- y. MOC of Rasching / pall Ring & size :

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1.2 DEGASSER BLOWER WITH MOTOR

- | | |
|--|---|
| 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 Blower assembly | : |
| k. Noise level measured at 1 m distance | : |

2.0 DM PLANT SAC, SBA & MB

2.1 VESSEL	SAC	SBA	MIXED BED
a. Quantity	:		
b. Type	:		
c. Net output, m3/hr	:		
d. Gross output between regeneration excluding regeneration hours in M ³	:		
e. Productive output between each regeneration excluding regeneration hrs. in M ³	:		
f. Operating cycle excluding regen. Hrs.	:		
g. Duration of regeneration hrs.	:		
<i>Regeneration type</i>	:		

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DM PLANT VESSEL	SAC	SBA	MIXED BED
h. Material of Construction of Vessel			
i. Diameter -shell mm :			
j Thickness-shell & Dish End mm :			
k. Design Flow Velocity m ³ /hr/m ² :			
l. Maximum velocity permitted m/s:			
m. Internal protection :			
Lining Material and thickness:			
n. Shore hardness :			
o. External protection :			
p. Design Code :			
q. Corrosion Allowance-Shell/ DE mm :			
r. Thinning allowance- DE mm :			
s. Design Pressure :			
t. Test Pressure :			
u. Vessel dia x st. height x tot. ht mm:			
v. Resin bed ht. mm :			
w. Free Board % :			
x. Nozzles size & rating :			
-			
-			
-			
-			
y. No.of sight glasses & size :			
z. No of manholes & size :			
aa. Details about distributor nozzles:			

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2.2	RESIN DETAILS	SAC	SBA	MB
	a. Resin make & Model No.	:		
	b. Resin quantity, M3	:		
	c. Resin Type	:		
	d. Bed Depth , M	:		
	e. Resin Life, years	:		
	f. Ionic load as CaCO ₃ mg/l	:		
	g. Regeneration level, kg/m ³	:		
	h. Operating Exchange Capacity} as CaCO ₃ kg/m ³	:		
	i. Derated Exchange Capacity, kg/m ³ :	:		
	j. Qty of Acid 30% /NaOH 48%	:		
	k. Time required / duration for Complete Regeneration	:		
	l. Head loss through exchanger, mWC	:		
	m. Resin Trap Qty in Nos	:		
	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	:		
2.3	REGENERATION CHEMICAL	SAC	SBA	Mixed Bed
	a. Type	:		
	b. Specification	:		
	c. Chemical Concentration	:		
	d. Grade	:		
	e. Quantity required for each Regeneration on % basis	:		
	f. Protection from outside if any	:		

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3.0 Measuring Tanks (SAC & SBA)	: Acid measuring Tank	Alkali measuring Tank
1 Quantity	: 1 no.	1 no.
2 Type	:	
3 Capacity Its	:	
4 Dimensions (dia x ht)	:	
5 MOC	:	
6 Internal protections, if any	:	
7 Thickness of lining	:	
8 Lining Material	:	
9 Agitator quantity	:	
10 Agitator M.O.C	:	
11 Level indicator make & details	:	
12 Level switch/ Transmitter make & details	:	
13 Ejectors Make & model	:	

4.0 Measuring Tanks (Mixed Bed)	: Acid measuring Tank	Alkali measuring Tank
1 Quantity	:	
2 Type	:	
3 Capacity Its	:	
4 Dimensions (dia x ht)	:	
5 MOC	:	
6 Internal protection, if any	:	
7 Thickness of lining	:	
8 Lining Material	:	
9 Agitator quantity	:	
10 Agitator M.O.C	:	
11 Level indicator make & details	:	
12 Level switch/ Transmitter make & details	:	
13 Ejectors Make & model	:	

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5.0 DATA SHEET FOR RO STAGE-II PERMEATE SUPPLY / DM REGENERATION CENTRIFUGAL PUMP WITH MOTORS

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 :		

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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

		DM FEED	DM REGEN
a. Orientation	:	Horizontal	Horizontal
b. Suction / Discharge nozzle			
- Size	mm :	/	/
- Rating	psi :	/	/
- Flange drilling standard	:	/	/
- Nozzle Orientation looking from drive end	:	/	/
- Material	:	/	/
c. Material of Construction / Make			
- Pump Casing	:		
- Impeller	:		
- 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	:		

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g. BEARINGS

- Type :
- Make :
- Lubrication oil spec. :
- Lubricaion 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 :

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d. Accessories details :

6.0 MIXED BED AIR BLOWER WITH MOTOR

a. Qty. offered :

b. Type & make :

c. Capacity M3/hr :

d. Head mWC :

e. Efficiency :

f. Power rating of Motor :

g. MOC – Casing :

Lobe :

Shaft & Sleeve :

h. Noise level :

i. Vibration level :

k. Accessories confirmation

Base frame

Anti-vibration Mountings

Silencer

Suction filter

Pulleys with V-belt

Pr. Relief Valve

Flexible discharge connection

Pressure Gauge

Non-return valve

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VALVE SCHEDULE –DATA SHEET

Annexure- 4

Sl. No	Application	Type	Size	Pr Rating-BAR	Qty	MOC of wetted Parts				ACTUATOR DETAILS
						Body	Disc / Diaphragm	Stem / Shaft	Lining	
1	Manual Valves									
2	Pneumatic Valves									

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ANNEXURE -5

TECHNICAL DEVIATIONS

Sl. No	Section no.	Clause No.	Page / No.	Specification	Statement of Deviations/variatio	Reason for Deviation	cost of withdrawal

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SECTION – 9

ERECTION, COMMISSIONING, PG TEST, AND HANDING OVER

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1.0 **SCOPE OF SERVICES**

The scope of Erection and Commissioning of systems {De-Gasser System and DM 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, and handling over of these systems.

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-PSSR'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 DM system at site.**

- a. 2 x 100% (1W+1S) Degasser towers with accessories
- b. 4 x 100% (2W+2S) Degasser Blowers with drive motors & accessories
- c. 3 x 50% (2W+1S) RO stage-II permeate supply pumps with drive motors and all accessories.
- d. 2 x 50% (2W) strong acid Cation (SAC) Exchanger units with all accessories, resins, internals, frontal piping etc.
- e. 2 x 50% (2W) strong basic Anion (SBA) Exchanger units with all accessories, resins, internals, frontal piping etc.
- f. 3 x 50% (2W+1S) Mixed Bed (MB) Units along with all accessories, internals, resins, frontal piping etc.
- g. 2 x 100% (1W+1S) Mixed Bed Air Blowers with drive motors and all accessories for regeneration
- h. 2 x 100% (1W+1S) DM regeneration pumps with drive motors and all accessories.
- i. 1 x 100% (1W) Acid measuring tank (AMT) & accessories [for SAC regeneration]
- j. 1 x 100% (1W) Acid measuring tank (AMT) & accessories [for MB regeneration]
- k. 2 x 100% (2W) Acid dosing ejectors & acc.
- l. 1 x 100% (1W) Caustic measuring tank (CMT) & accessories [for SBA regeneration]
- m. 1 x 100% (1W) Caustic measuring tank (CMT) & accessories

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[for MB regeneration]

- n. 2 x 100% (2W) caustic dosing ejectors & acc.
- o. 1 set of Valves as per enclosed P &ID
- p. 1 set of interconnecting piping/ducting system including valves and accessories etc. for the following areas as per the **enclosed P &ID**.
 - Degasser system to RO stage-II permeate tank
 - Degasser blowers to degasser(ducting)
 - Suction & discharge piping for RO stage-II permeate supply pumps
 - RO stage-II permeate supply pumps to SAC vessels
 - SAC vessels to SBA vessels
 - SBA vessels to MB vessels
 - By pass piping from RO stage-II permeate supply pumps to MB vessels
 - MB blowers to MB vessel
 - DM regeneration pumps suction piping from DM Water storage tank upto pumps and recirculation line to DM water storage tank.
 - DM regeneration pumps discharge to DM system
 - Piping from bulk chemical storage system to AMT/CDT
 - AMT/CDT area to DM system.
 - MB outlet piping from vessel to outside of RO-DM plant building.
- q. 1 set of applicable foundation bolts, fasteners, safety shower – 2 nos, gaskets, supports, ladder, platforms and miscellaneous items etc.
- r. Electrical, Controls & Instrumentation as per specification / P&ID.
- s. 1 set of Electrical, Controls & Instrumentation as per specification & PID & ROS: 4160
- t. 1 set of Commissioning spares
- u. 1 set of mandatory spares as per Annexure.

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 , and handing over of MB 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

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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 carryout 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.

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- 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).

14.0 EXCLUSIONS

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

- 14.1 All civil works pertaining to DM Plant are excluded from the scope of the bidder.
- 14.2 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.
- 14.3 Electricity (3 phase) will be available to the bidder at one point near RO-DM Plant on free of charge for erection purpose.
- 14.4 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.
- 14.5 Chemicals for commissioning and trial operation of the plant will be supplied by BHEL.
- 14.6 Storage of shipped items / container at BHEL store as of received condition will be taken care by BHEL.

15.0 Specification, Standards & Codes:

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

16.0 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.

17.0 Tools and Tackles:

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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.

18.0 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.

19.0 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.

20.0 Additional requirements

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

20.2 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.

21.0 GENERAL INSTRUCTIONS TO THE BIDDER

21.1 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.

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- 21.2 Bidder shall contact BHEL and obtain additional details/data if any required to submit proper quotation.
- 21.3 The Bidder shall include all necessary commissioning spares in his basic scope of supply.
- 21.4 Adequate lighting facilities such as low volt hand lamps shall be arranged by the contractor at the site of construction etc. at his cost.
- 21.5 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.
- 21.6 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.
- 21.7 At periodic / intervals of work, complete and detailed account of the equipment so for erected shall be submitted to the BHEL Engineer.
- 21.8 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.
- 21.9 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.
- 21.10 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.
- 21.11 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 .

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21.12 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.

21.13 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.

21.14 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.

22.0 SITE CLEANLINESS AND SAFETY REQUIRMENTS:

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

22.2 Providing of safety equipments like Helmet, safety goggle, hand gloves 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.

22.3 Contractors shall ensure that the quality is maintained in all the works connected with this contract at all stages of the requirement of BHEL.

22.4 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.

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22.5 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.

23.0 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.

24.0 PROVIDENT FUND & MINIMUM WAGES

24.1 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.

24.2 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.

25.0 OTHER STATUTORY REQUIREMENTS:

25.1 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.

25.2 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

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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.

- 25.3 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.

26.0 TIME OF COMPLETION

- 26.1 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.

- 26.2 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.

27.0 ENGAGEMENT OF LABOUR

- 27.1 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.

- 27.2 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.

28.0 COMPLIANCES WITH LABOUR LAWS & RULES

- 28.1 The contractor shall comply with all state and central Laws, statutory rules, regulation 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

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h. Contract Labour (Regulation & Abollition) Act, 1970

29.1 TAXES & DUTIES:

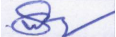
The contractor shall pay all taxes, VT, licence fee, deposits, duties, royalty, commissions or other charges, other than such taxes specifically mentioned in the special conditions of contract, which may be leviable on account of any of his operations in executing the contract. In case BHEL is forced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

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**TECHNICAL SPECIFICATION FOR ELECTRICAL, CONTROLS &
INSTRUMENTATION FOR**

DEMINERALISATION PLANT

(SAC, SBA, MB)

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Rev.No	Date	Prepared	Checked	Approved	Remarks

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1. CODES AND STANDARDS

All equipments, system and service covered under this specification shall comply with the requirements of the latest statutes regulations and safety codes as applicable in the locality where the equipments/systems will be installed. The Bidder shall fully acquaint himself with these requirements and shall ensure compliance with them. The equipments, systems and services furnished as per this specification shall conform to the codes and standards elsewhere in the specification. However in the event of any conflict between the requirements of two standards or between the requirements of any standard and this specification, the more stringent requirements shall apply unless confirmed otherwise by the Owner in writing. The decision of the Owner shall be final and binding in all such cases.

1.1. Reference Codes and Standards

The design, manufacture, inspection, testing, site calibration and installation of all equipment and systems covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable ANSI, ASME, IEEE, NEC, NEMA, ISA, DIN, VDE, NFPA, IEC, EIA, TIA and Indian Standards and their equivalents. Bidder to note that in no case, OEM/manufacturers own standards shall be accepted.

1.1.1. Temperature Measurement

1. Performance Test Code for temperature measurement ASME PTC 19.3 (1974 – R 1998)
2. Temperature measurement - Thermocouples ANSI-MC 96.1 – 1982, IEC 584
3. Temperature measurement by electrical resistance thermometers - IS-2806.
4. Thermometer-element-platinum resistance-IS-2848, IEC 751/DIN 43760
5. RTD Design Code – DIN EN 60751:1996, BS EN 60751 : 2008
6. Thermowell Design Code – ASME PTC 19.3 TW – 2010

1.1.2. Pressure Measurement

1. Performance Test Code for pressure measurement - ASME PTC 19.2 (2010)
2. Bourdon tube pressure and vacuum gauges - IS 3624, IS 3602, ASME B 40.1

1.1.3. Electronic measuring Instruments & Control hardware

1. Automatic null balancing electrical measuring instruments - ANSI C 39.4 (Rev. 1973), IS 9319
2. Safety requirements for electrical and electronic measuring and controlling instrumentation - ANSI C 39.5 - 1974.
3. Compatibility of analog signals for electronic industrial process instruments - ISA-S 50.1:ANSI MC 12.1 - 1975.
4. Dynamic response testing of process control instrumentation - ANSI MC 4.1 (1975): ISA-S26 (1968).
5. Surge withstand capability (SWC) tests - ANSI C 37.90A (1974) IEEE Std. 472 (1974). IEC – 255.4.
6. Printed circuit boards - IPC TM-650, IEC 326 C
7. General requirements and tests for printed wiring boards - IS 7405 (Part-I) - 1973

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8. Edge socket connectors - IEC 130-11.
9. Requirements and methods of testing of wire wrap terminations DIN 41611 Part-2.
10. Dimensions of attachment plugs & receptacles ANSI C73-1973.
11. Direct acting Electrical Indicating Instruments: IS-1248-1968.

1.1.4. Instrument Switches and Contacts

1. Contact rating - AC services NEMA ICS Part-2 125, A600
2. Contact rating - DC services NEMA ICS Part-2-125, N600.

1.1.5. Control Valves

1. Control Valve sizing - Incompressible fluids - ISA S39.2 - 1972.
2. Control valve sizing - Compressible fluids - ISA S39.3 - 1973, ISA S39.4 - 1974.
3. Face to face dimensions of control valves - ANSI B16.10
 - 1) ISA Hand book of control valves - ISBN B1047-087664-234-2.
 - 2) Valves - flanged, threaded and welding end : ANSI B 16.34(2009)
 - 3) Casting : ASTM A 216 / A 351 (2008)
 - 4) Welded end connection : As per ASME boiler and pressure vessel code / ANSI.B 16.34(2009), B16.25 (2009), B 16.11(2009).
 - 5) Defect removal: ANSI B 16.34 2009.
 - 6) Cleaning : ASTM A 380 2006.
 - 7) CV test : As per ISA procedure S 75.02 (2008).
 - 8) Control Valve seat leakage : ANSI/FCI 70.2

1.1.6. Enclosures

1. Types of enclosures - NEMA Std. ICS-6-110.15 through 110.22 (Type 4 to 13).
2. Racks, panels, and associated equipment - EIA: RS-310-B (ANSI C83.9 - 1972)
3. Protection Class for Enclosure, Cabinets, Control Panels and Desks - IS-13947-1962.

1.1.7. Flow measurement

1. ASME Performance Test Code PTC-19.5 (2004), ISA RP3.2
2. BS 1042
3. ISO 5167

2. GENERAL NOTES

- a) 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 mentioned in this specification.
- b) The Bidder shall provide all necessary inputs to enable the Purchaser (BHEL) to design & procure the LT MCC, DCS etc., for the system.
- c) General site conditions are furnished under "Project Information" elsewhere as part of the specifications or other associated specifications. All E,C&I equipments shall be suitable for the site conditions indicated therein.

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- d) The System shall be designed suitable for Auto Operation through a DCS system to be arranged by BHEL. This DCS system will cover the requirements of the Ultra Filtration (UF), SWRO & BWRO system of filtration plant. The system Bidder shall provide necessary Electrical, Control & Instrumentation equipments, Pneumatic Operated Valves (POVs), Control Valve etc. in his plant to facilitate auto operation.
- e) The system Bidder should furnish a “Control philosophy with control logic” explaining the controls, interlocks etc., for the system which have to be arranged by the purchaser in the DCS system. Necessary Valve Sequence Charts, Logic Diagram control philosophy, list of interlocks etc., have to be furnished during detailed engineering to facilitate implementation of the system controls & interlocks in the DCS system.
- f) Based on the inputs furnished by system Bidder, the DCS Bidder will prepare the engineering software in the form of logic diagrams for the system portion. The system Bidder shall review and approve the logic diagram for implementation. At this stage of checking & approval the system Bidder should not call for any considerable number of additional I/Os over & above the I/O list given in his offer. Once the system requirements are implemented in the 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.
- g) Analytical instruments for pH / ORP / Conductivity / Silica / Turbidity / TOC / Dissolved Oxygen etc. as applicable shall consist of sensor & microprocessor based analyser which shall be located in the field. Only 4 - 20mA output signals from the analysers shall be brought to the 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.
- h) To facilitate operation of the system, valve operation shall be pneumatically operated. Accordingly Bidder to indicate the Instrument air requirement taking into consideration that at a time all the working streams shall be operated.
- i) **All the instruments supplied by the Bidder must meet BHEL's specification and will have to be procured from the approved Bidders list only.**
- j) All electrical equipment shall be suitable for the power supplies, fault levels and other climatic conditions indicated in “Project Information” enclosed with the specification.
- k) The detailed specification of various electrical / control equipments and supply system are given in the respective sections of this specification.
1. For Low Pressure application (Sea/saline water), MOC of impulse tubing & fittings shall be **CPVC (3/8”) Sch80, Industrial grade**. For whichever instruments, manifolds are applicable, the MOC of impulse tubes, fittings (from manifold to instrument) and manifold shall be of **Super Duplex/ Duplex SS MOC**. For High pressure application (SWRO feed & brine line), MOC of Impulse tubing & fittings shall be **Super Duplex/ Duplex SS (1/2”)**, MOC of fittings &

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manifold shall be **Super Duplex/ Duplex SS (1/2")**. MOC/Equipment for installation shall be as mentioned above which is subject to customer approval.

MOC mentioned here shall supersede over any other MOC mentioned elsewhere in this specification.

l) Oder of priority of documents is as follows

1. PID
2. BOQ
3. Specification/Datasheet

In case any conflict between above documents customer decision shall be final and bidder shall abide to the same without any price implication.

Additional requirements

- a) During execution stage, the bidder shall assist BHEL for obtaining the approval for various drawings / data sheets / documents pertaining to this package by visiting customer's premises along with the buyer
- b) The bidder shall supply all necessary calibration standard solutions / instruments as required for commissioning and until handing over the system to the end user.
- c) All instruments shall be offered to purchaser Engineers for inspection. Any instrument shall be dispatched from manufacturer's works only after obtaining written clearance from BHEL.
- d) Successful bidder shall conduct training on all instruments purchaser engineers at manufacturer's works and at site. The training include 10 days of training on the following:

Operation principle of all other Instruments

Calibration of all instruments

- e) After award of contract of bidder should submit the quality plan for BHEL approval for all the items covered in this package. O& M manuals for all the Instruments should be submitted in Hard & soft copies. (After award of contract)
- f) All mounting accessories for various instruments shall be supplied as a part of basic scope of this package.
- g) Erection hardware like root valves, impulse lines, 2 / 3 / 5 way manifold valves shall also be supplied as a part of basic scope of this package.
- h) All Electrical equipments and instruments shall be provided with suitable earthing terminals as per relevant IS standard.
- i) Instrument air will be made available at one point. Further distribution shall be taken care of by the system Bidder.

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- j) The specification for Instruments, instrument accessories shall be as per enclosed specification.
- k) Tag numbering philosophy would be uniform for the entire plant. There would a single, unique tag for a given equipment / signal.
- l) 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.
- m) All instruments shall be type-tested type. Only type tested instruments shall be supplied.
- n) All instruments shall undergo all routine tests. Test certificates for all supplies shall be furnished.

3. GENERAL INSTRUCTIONS TO THE BIDDER

- a) 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.
- b) Bidder shall contact owner / consultant and obtain additional details / data if any required to submit proper quotation.
- c) The owner reserves the right to omit any one or more items of work at any time of the contract without assigning any reason what so ever.
- d) The Bidder shall include all necessary commissioning spares in his basic scope of supply.

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4. ELECTRICAL AND C&I SYSTEM ACTIVITIES

SL. NO	ELECTRICAL, C&I SYSTEM ACTIVITY BY THE BIDDER
4.1.	Design, Manufacture / procurement, testing at manufacturer's works, packing delivery of the instruments to site for complete skid.
4.2.	Obtaining approvals from end customer for the specification, makes, model numbers of the instruments, GA drawing,
4.3.	Furnishing the Inputs required for LTMCC engineering such as Electrical Load list with KW rating, number of drives.
4.4.	Furnishing the Inputs required for DCS engineering such as Sequential Flow Chart, Control philosophy, Detailed IO list, Alarm list for the total system
4.5.	Furnishing the data sheets for Instruments in BHEL Format.
4.6.	Preparation of Instrument Hook-up & installation drawings
4.7.	Supply of LT motor along with cable glands & lugs
4.8.	Supply of instruments with fittings as per enclosed PIDs with in the skid.
4.9.	Supply of instruments as loose item as per enclosed PIDs as per the specification.
4.10.	Supply of Pneumatic Operated Valves (POV's), Motorised Operated Valves(MOVs) & Solenoid Operated Valves(SOVs) as per enclosed PID
4.11.	Supply of required erection materials for instrument Air line from Solenoid valve enclosure box to POV's (¼" OD PVC insulated copper tube, Air filter regulator, Fittings & acc)
4.12.	Supply of required erection materials for Instruments impulse line (Root valves, 2 / 3 / 5 Way manifold for instruments, Drain valves, ½" DUPLEX SS / SS316 SSL Tube, SS Fittings, supporting structure etc)
4.13.	Supply of Mandatory spares as per enclosed list.
4.14.	Supply of Commissioning as per specification.
4.15.	Supply of Recommended spares.
4.16.	Support for obtaining all necessary statutory clearance for the installation
4.17.	Calibration of all instruments at site with standard calibration solutions & standard instruments at every 3 months till handing over.
4.18.	Supply of special tools required for erection & commissioning of instrumentation system. List to be given in technical offer by bidder.
4.19.	Carrying out pre commissioning Checks & test at site
4.20.	Assistance for 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)
4.21.	Providing training to BHEL & End user (BHEL Customer) at site
4.22.	After commissioning the instruments to the satisfaction of the end user (Customer) the successful bidder shall extend support to BHEL & Customer till the guarantee period for the following. a) Recalibration of all instruments b) Rectification / Repair / Replacement of defective components
4.23.	Submission of Erection, Operation & Maintenance manual in required

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	number of copies.
4.24.	Furnishing unit price of various components for addition / deletion purpose for all components of instruments, erection accessories.

5. Deleted

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6. ELECTRICAL AND C&I SCOPE OF WORK BETWEEN BHEL & BIDDER

SL. NO	ELECTRICAL SYSTEM	ACTIVITY	AGENCY
6.1.	415V MCC PANEL	SUPPLY ERECTION	BHEL BHEL
6.2.	LT MOTORS FOR PUMPS SUPPLIED BY BIDDER(AS PER ENCLOSED P&ID)	SUPPLY ERECTION	BIDDER BIDDER
6.3.	LT POWER CABLE FOR MOTORS	SUPPLY ERECTION	BHEL BHEL
6.4.	CONTROL CABLES AND INSTRUMENTATION CABLES.	SUPPLY ERECTION CHECKING	BHEL BHEL BHEL
6.5.	SPECIAL CABLES (REFER NOTE 3)	SUPPLY ERECTION	BIDDER BIDDER
6.6.	CABLING MATERIAL (CABLE TRAYS, SUPPORT MATERIAL ACCESSORIES, AND CONDUITS ETC.)	SUPPLY ERECTION	BHEL BHEL
6.7.	START STOP PUSH BUTTON STATION FOR MOTORS	SUPPLY ERECTION	BHEL BHEL
6.8.	EQUIPMENT EARTHING	SUPPLY ERECTION	BHEL BHEL
6.9.	JUNCTION BOXES	SUPPLY ERECTION	BIDDER BIDDER
6.10.	LAYING & TERMINATION OF DIGITAL / ANALOG INSTRUMENT CABLES / CONTROL CABLES BETWEEN EQUIPMENT & JUNCTION BOXES.	SUPPLY ERECTION CHECKING	BHEL BIDDER BIDDER
6.11.	LAYING & TERMINATION OF DIGITAL / ANALOG INSTRUMENT CABLES / CONTROL CABLES BETWEEN JUNCTION BOXES & DCS	SUPPLY ERECTION CHECKING	BHEL BHEL BHEL
6.12.	CABLE SCHEDULE & CABLE INTERCONNECTION DRG .	PREPARATION VETTING	BIDDER BHEL
6.13.	BELOW GROUND EARTHING, LIGHTING, A/C AND VENTILATION	SUPPLY ERECTION	BHEL BHEL
6.14.	INSTRUMENTS WITH FITTINGS AS PER SPECIFICATION, IMPULSE PIPING FROM INSTRUMENTS TAPPING TILL INSTRUMENTS (As per P & ID and Hook Up drawing enclosed)	SUPPLY ERECTION COMM. TECHNICAL ASSISTANCE	BIDDER BIDDER BIDDER
6.15.	INSTRUMENTS AS LOOSE ITEM	SUPPLY	BIDDER

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	AS PER THE SPECIFICATION (If Applicable)	ERECTION COMMG. TECHNICAL ASSISTANCE	BIDDER BIDDER BIDDER
6.16.	DCS SYSTEM – SYSTEM BIDDER TO EXTEND TECH. ASSISTANCE FOR ESTABLISHING THE SYSTEM IN AUTO	SUPPLY ERECTION COMMG TECHNICAL ASSISTANCE	BHEL BHEL BHEL BIDDER
6.17.	INSTRUMENT AIR LINE TILL SVEB	SUPPLY ERECTION COMMG.	BIDDER BIDDER BIDDER
6.18.	IMPULSE PIPING AND FITTINGS FROM SVEB (INCLUDING SVEB WITH AFR) TO PNEUMATIC ACTUATOR) (Refer Note 6).	SUPPLY ERECTION COMMG.	BIDDER BIDDER BIDDER
6.19.	ANY LOCAL PANEL FOR INSTRUMENTS, TRANSMITTER RACKS ETC.(IF APPLICABLE)	SUPPLY ERECTION COMMG.	BIDDER BIDDER BIDDER
6.20.	CALIBRATION OF INSTRUMENTS		BIDDER

NOTES:

1. Necessary layout inputs shall be furnished by bidder for bidder supplied equipment.
2. Cable gland & Lugs shall be provided by Bidder for equipment supplied by Bidder.
Cable glands shall match to cable sizes where cables are supplied by purchaser. Cable sizes shall be furnished to the Bidder during detailed Engineering.
3. Cables other than Power, Control & Screened control cables are special cables (eg. cable between sensor & analyser).
4. All chemicals, buffer solution and accessories required for calibration of instrument shall be supplied by bidder.
5. All field instruments shall be provided with prefabricated canopy made of GI sheet with bolted construction.
6. All actuators shall be provided with canopy by bidder. Solenoid valve enclosure box along with AFR and copper tubing till the pneumatic valves is in BIDDER's scope. Bidder supplied POVs which are placed in remote location shall have Pneumatic Actuator with canopy, SOVs and AFR. Those valves shall be identified during detailed engineering.

7. LIST OF DRAWINGS / DOCUMENTS

to be submitted along with offer.

The bidder shall submit the following documents along with the offer:

- a) Signed conformation of BHEL specification in total for the subject enquiry.
- b) Instrument Schedule indicating instrument type, location, Quantity, operating parameters, measuring range, Makes in BHEL Format

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- c) Valve schedule indicating valve type, location, Quantity, operating parameters, measuring range, Makes in BHEL Format
- d) Bidder P & ID
- e) I / O list with number of DI, DO, AI, AO required for entire package
- f) Electrical Load List indicating KW rating and no. of drives shall be furnished along with offer
- g) Unit price for addition / deletion purposes during detailed design commissioning at site (in a separate sealed cover).
- h) Schedule of Technical Confirmations – Schedule-A
- i) Schedule of Technical deviations(if any) – Schedule-B

to be submitted after placement of purchase order for the approval of the Purchaser, for all items under the scope of supply:

- a. Data Sheet for Medium Voltage Squirrel Cage Induction Motor as per cl.no 9.16
- b. Detailed I / O list
- c. Datasheet for Pneumatic operated Valves
- d. Trouble shooting manual and maintenance manuals
- e. Maintenance instructions for trouble shooting, routine adjustments, assembly & disassembly instructions, off-line testing
- f. O&M manual 6 copies of all items (for information).
- g. Technical data sheet for all instruments supplied in BHEL Format
- h. List of commissioning spares to be supplied as mentioned elsewhere in the specification.
- i. List of mandatory spares to be supplied as mentioned elsewhere in the specification.
- j. List of recommended spares with price offer.
- k. List of Tools & tackles
- l. List of calibration tools & Instruments
- m. Shipping list with details of individual item supplied.
- n. Dimensional drawings, mounting / installation drawings, materials of construction, Terminal Drawing for Solenoid Valve Enclosure Boxes supplied
- o. Test certificates for all supplied items including but not limited to Instruments, Solenoid valve Enclosure Boxes.
- p. Instruments, POV's ,MOV's and SOV's Installation and Hook up drawings for all items
- q. Operation sequence chart, control logic chart and control philosophy for system operation.

8. PROJECT INFORMATION:

Customer: TANGEDCO
Consultant: DESEIN
Location: Ennore

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For details refer ROS 6162.

9. SPECIFICATION FOR LT MOTORS

9.1. 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 and all other motors will be 415V, 3 Ph, 50 Hz motors unless otherwise specified.

9.2. CODES AND STANDARDS

All motors shall confirm to the latest editions including all applicable amendment of relevant IS, IEC and CBIP standards/Publications. In case any other standard is followed that ensures equal or better quality, may be accepted. However the English version of the Standard adopted shall be submitted.

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:. Any other applicable Indian standards for any component part even if not covered in the list shall also be followed

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

IEC:60034: Rotating electrical machines

IS: 6362: Designation of methods of cooling of rotating electrical machines

IS: 2253: Designation for type of construction and mounting arrangement of rotating electrical machines

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9.3. DESIGN REQUIREMENTS

9.3.1. All LV motors will be suitable for 415V, 3 Phase, 50 Hz power supply except motors rated with 0.2 KW & below. System fault level shall be 50kA for 1 Sec. For the purpose of design of equipments /systems, an ambient temperature of 50 °C and relative humidity of 85% shall be considered. The equipment shall operate in a highly polluted environment.

9.3.2. All LV motors above 10 kW with S1 duty shall be compulsorily of Energy efficient level IE 2 as per IS 12615: 2011.

9.3.3. The motor rating shall be arrived at considering 15% margin over the duty point input or 10% over the maximum demand of the driven equipment, whichever is higher, considering highest system frequency. All motors shall be continuously rated (S1 duty). However, crane motors shall be rated for S4 duty, 40% cyclic duration factor. Whenever the basis for motor ratings are not specified in the corresponding mechanical specification sub-sections, maximum continuous motor ratings shall be at least 10% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations.

9.3.4. All motors shall be suitable for direct on line starting through any type of breaker

9.4. STARTING REQUIREMENTS

9.4.1. 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.

9.4.2. Starting Voltage requirement motors :85 % of rated voltage for all motors. Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

9.4.3. For motors with starting time up to 20 secs at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 secs more than starting time .

9.4.4. For motors with starting time more than 20 secs and up to 45 secs at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs more than starting time.

9.4.5. For motors with starting time more than 45 secs at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.

9.4.6. Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.

9.4.7. Motors shall be capable of restarting under full load after a momentary loss of voltage with the possibility of 150 % nominal voltage during fast bus transfer.

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9.4.8. 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.

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

9.6. Transient voltage dip on starting of the largest motor with DOL shall be limited to 20% of the nominal system voltage at the voltage terminals.

9.7. TORQUE REQUIREMENTS

9.7.1. Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.

9.7.2. Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.

9.8. The following frequency of starts shall apply

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

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

9.9. RUNNING REQUIREMENTS

9.9.1. Minimum voltage required for starting the motors shall be 85% of rated voltage

9.9.2. 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.

9.9.3. 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.

9.10. STRESS DURING BUS TRANSFER

9.10.1. All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.

9.10.2. The motors shall be suitable for bus transfer schemes provided on the 11 kV, 3.3 kV/415V systems without any injurious effect on its life.

9.10.3. 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.

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

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

9.11. LOCKED ROTOR WITHSTAND TIME

9.11.1. Locked rotor current of the LV motor shall not exceed 600% of full load current inclusive of IS tolerance.

9.11.2. The locked rotor withstand time under hot condition at 110% rated voltage shall be more than motor starting time at minimum permissible voltage of 80% rated voltage 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.

9.11.3. 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.

9.12. CONSTRUCTIONAL FEATURES

9.12.1. Canopy shall be provided for outdoor motors.

9.12.2. Bidder shall provide fully compatible electrical system, equipments, accessories and services.

9.12.3. All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes & Standards, especially the Indian Statutory Regulations.

9.12.4. All motors below 15 kW shall be provided with sealed ZZ bearings.

9.12.5. Motors shall be designed to easy access for drilling holes through motor feed of mounting flange for installation of dowel pins after assembly of the motor and driven equipment.

9.12.6. For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired up to the terminal box.

9.12.7. Degree of Protection

Indoor Motors: IP 54

Outdoor Motors: IP 55

Cable Box-Indoor area: IP 54

Cable Box-Outdoor area: IP 55

9.12.8. Non-hygroscopic, oil resistant, flame resistant

9.12.9. Suitable single phase space heaters shall be provided on motors rated 30 kW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided.

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9.12.10. Motors upto 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

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

9.12.12. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.

9.12.13. Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

9.12.14. 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.

9.12.15. Winding and insulation

All insulated winding shall be of copper.

Windings shall be impregnated to make them non hygroscopic and oil resistant.

Two hot starts in succession, with motor initially at normal running temperature

Class 'F' with temperature rise limited to class 'B'

9.12.16. Noise and vibration

The peak amplitude of the vibration shall be within IS specified limits.

Noise level and vibration shall be limited within the limits prescribed in IS: 12065 & IS: 12075 respectively. Motors shall withstand vibrations produced by driven equipment.

9.12.17. Grounding

Motor body shall be grounded at two earthing points on opposite sides with two separate and distinct grounding pads complete with tapped holes, GI bolts and washers.

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

LT Motors	
a. Fractional HP	8 SWG GI wire
b. Up to 25 KW	25 x 3 mm flat
c. 25 to 125 KW	25 x 6 mm flat
d. above 125 KW	50 x 6 mm flat
Control Desks, Control/relay panels, LDBs, PDBs, Lighting Panels, Power receptacles, Lighting Masts, Lighting Poles	25 x 3 mm flat
LPB stations, Limit/Pressure switches, Starters, CT/PT terminal Boxes	8 SWG GI wires
Columns, Fence, Gates, Cable trays etc	50 x 6mm flat

9.12.18. The cable terminal box shall have a separate grounding pad, Terminals and Terminal Boxes.

9.12.18.1. The motor terminal box shall be suitable for withstanding the maximum system fault current for a duration of at least 0.25 seconds.

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9.12.18.2. 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.

9.12.18.3. 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

9.12.18.4. Unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on top or left hand side of the motor when viewed from the non-driving end.

9.12.18.5. 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.

9.12.18.6. 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.

9.12.18.7. 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.

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

9.12.18.9. 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.

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

9.12.18.11. Suitable Double Compression type Cable glands and cable lugs shall be provided. Cable lugs and lugs shall be as specified elsewhere in the specification. The cable sizes will be informed during detail engineering.

9.12.18.12. 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.

9.12.19. Painting -Motor including fan shall be painted with corrosion proof paints of colour shade Siemens grey (RAL 7032).

9.12.20. Lifting Provisions

Motor weighing 25 kg or more shall be provided with eye bolt or other adequate provision for shifting.

9.13. GENERAL

9.13.1. Motors provided for similar drives shall be interchangeable.

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

9.13.3. Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956

9.13.4. 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.

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

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

9.13.7. Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.

9.14. INSPECTION AND TESTING

9.14.1. All materials, components and equipment covered under this specification shall be procured, manufactured, as per the Approved quality plan

9.14.2. 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.

9.14.3. 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.

9.14.4. LIST OF TESTS TO BE CONDUCTED FOR HV, MV and LV MOTORS

9.14.4.1. TYPE TESTS

- (a) No load saturation and loss curves up to approximately 115% of rated voltage
- (b) Momentary overload test
- (c) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., core temp., coolant flow and its temperature shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.
- (d) Surge withstand test on the sample coil after placing it in stator core at (4U + 5 KV) and with at least five impulse of 1.2/50 micro sec. wave, for HV motors only, where U is the line to line voltage in kV.
- (e) Surge-withstand test with 0.3/3 micro sec. wave on each type of 3.3/11 kV motor coils with at least five such impulses, followed by one minute power frequency high voltage test on turn to turn insulation, after cutting the coil and bringing out the turns suitably. The power frequency test voltage shall be decided during detailed engineering.
- f) Dimensions (for motors covered by IS 1231:1974 and IS 2223:1983 only)
- g) Measurement of resistance of windings of stator and wound rotor.
- h) Reduced voltage running up test at no load (for squirrel cage motors up to 37kw only)
- i) Full load test to determine efficiency, power factor and slip.
- j) Insulation resistance test
- k) Test for vibration severity of motor
- l) Test for noise levels of motor
- m) Test for degree of protection by enclosure
- n) Temperature rise test at limiting values of voltage and frequency variations
- o) Over speed test

9.14.4.2. ROUTINE TESTS

The following shall constitute the routine tests.

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- a) Insulation resistance test
- b) Measurement of resistance of windings of stator and wound rotor.
- c) No load test
- d) Locked rotor readings of voltage, current and power input at a suitable reduced voltage
- e) Reduced voltage running up test (for squirrel cage motor)
- f) Open circuit voltage ratio of stator and rotor windings (for slip ring motors); rotor;
- g) High voltage test

9.14.5. INSPECTION AND TESTING AT SITE

9.14.5.1. Insulation resistance of 415V motors shall be measured between the winding of the machine and its frame by means of a 500/1000V megger. A minimum value of 1 mega ohm for 415V motors shall be considered a safe value. In case of lower I.R. Value, the insulation value shall be brought up by any of the following methods as desired by the Site Engineer:

- (a.) Blowing hot air in case of big motors.
- (b.) Putting the motor in electric oven in case of smaller motors.
- (c.) Placing heaters or lamps around and inside in case of small motors after making suitable guarding and covering arrangements so as to conserve the heat.

9.14.5.2. Site Test

- (a.) Measurement of vibration.
- (b.) Measurement of insulation resistance and polarization index.
- (c.) Measurement of full load current.
- (d.) Test running of the motors, checking the temperature rise and identifying the hot spot etc.

9.15. 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.
 - ii) Speed vs. time at rated 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.

V) Load performance curves.

9.16. DATA SHEET

LT MOTORS (A.C.)

01. Application :

02. Type : Energy Efficient (IE2)

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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 : $\pm 10\%$.
09. Allowed frequency variation : (+) 3% and (-) 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 :
13. Degree of protection :
14. Method of ventilation :
15. Class of insulation : "F" (temp.rise limited to class.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%)

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21. Motor efficiency and P.F.AT :
a) 100 % load
b) 75% load
c) 50% load
d) 25% 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
a) rated voltage :
b) Min. Voltage :
c) Max. 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 : (70°C for air cooled motors)
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 :
32. Type of mounting and shaft
Orientation :

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33. Location of terminal box :
viewed from driving end
34. Type and number of terminals :
brought out
35. Type and size of cable gland & lugs
for power cables & (if applicable)space heater cable : (size will be given during
Detail engg)
36. Cable gland entry side :
37. Tropical &fungicidal treatment :
38. GD² of the motor :
39. Weight of the motor :
40. Space heater Rating & other details
(for 30KW and above motors) :

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10. SPECIFICATION FOR FIELD & MEASURING INSTRUMENTS

10.1. GENERAL REQUIREMENTS

Instruments, control devices and other equipment accessories covered under this specification shall be furnished in accordance with I&C specification sheets and drawings enclosed herewith and the requirements of all applicable clauses of this specification.

The instrumentation and control equipment shall conform to all applicable codes and standards including those referred in elsewhere. All equipment and systems shall also fully comply with the design criteria stated elsewhere in the specification.

The instrumentation/control equipment and accessories shall be from the latest proven design for which the performance and high availability have been demonstrated by a considerable record of successful operation in power station service for similar applications. The bidder shall furnish sufficient evidence to fully satisfy the Owner in this regard.

For plug in type instruments, The plug & sockets shall be polarized to prevent wrong connections and have facility for secure coupling in plug-in position to prevent loose connections.

Signal/Electrical connection shall be screwed connection with double compression type Nickel-plated brass cable glands for Explosion proof area, Flame proof area and high vibration prone area.

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

All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified (Explosion proof for NEC article 500, class 1, Division 1 area & flame proof) and an anti corrosive paint shall be applied to the field mounted enclosures / instruments. All the field instruments shall also be provided with SS tag nameplate and double compression type Nickel-plated brass cable gland. Gaskets, Fasteners, Counter and mating flange shall also be included wherever required with the field instruments.

Following minimum requirement of field instruments shall be fulfilled by Bidder (In addition, Redundancy criteria for field instruments shall be as specified elsewhere in specification): -

- i. Level switches / pressure switches / flow switches/any other process switches etc. for OLCS / Alarms / Interlocks / Protection. Pressure switches at inlet, outlet of individual pumps and discharge header of pumps for protection and auto start / stop & alarms.
- ii. Level switches for sump/tank level high/normal/ low/very low interlocks.
- iii. Level Transmitters (Type as per Owner approval) for open sump/ tank/bunker/vessel/heaters.
- iv. Stand pipes on both side of tank for all level instruments (LT, LS & LG).

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- v. Flow elements with flow transmitter & Flow meter for flow measurement of process medium like Steam, Water, Air, Flue Gas, Fuel oil, open channel liquid, solid fuel, ash flow, DM water, Raw water, Instrument and Service air etc. as decided by owner.
- vi. Pressure gauges and temp. Gauges at inlet and outlet of each heat exchanger and cooler.
- vii. DPG, DPT & DPS across the filters/strainers.
- viii. Tapping points/test points shall be provided.
- x. All Thermocouples & RTDs shall be Duplex.
- xi. All Field Instruments used in acid or alkaline atmosphere shall be with standard Anti corrosion coating i.e. the combination of Polyurethane and epoxy resin baked coating (ANSI/ISA-71.04).
- xii. All primary instruments installed at "Minus level or Floor" shall be with protection class of IP 68.
- xiii. Transmitters (all type) for monitoring & controls purpose.
- xvii All field mounted push button, selector switch etc. shall be as per IEC or NEMA 4X protection.
- xviii All limit switch shall be conform to IEC-60947-5-1.
- xxi. Temp. Transmitters are envisaged with RTD & Thermocouples for monitoring services/application only. However any RTD & Thermocouples are used for control, interlock & protection application, same shall be directly wired to DDCMIS/DCS/PLC using instrumentation & Extension cables respectively.
- xxii. As for the water flow measurements, necessary flow elements/ transmitters are chosen in the process line and supplied such that their algebraic summation shall be mass balanced for calculating the system efficiency.
- xxiii. Contacts less, electronic 2-wire position transmitters shall be provided for all inching type motorised valve and dampers.
- xxv. Considering the type of application, wireless technology to bring signals to DDCMIS may be adopted by interfacing with OPC gateway to avoid cabling for smart level transmitters specified above at sr. no. xxiv. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner.
- xxvii. 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. All Instruments shall be provided with lugs & glands for terminating cables 2PX0.5 Sq.mm for signal and 3CX2.5 Sq.mm for instrument power supply. Terminal lugs furnished must be of the compression, insulated sleeve, half ring tongue type. Open-ended terminal lugs will not be accepted. Wires shall not be looped around the terminal screws or studs.

10.2. TRANSMITTERS, SWITCHES, GAUGES AND PANEL MOUNTED INSTRUMENTS

10.2.1. PRESSURE & DIFFERENTIAL PRESSURE GAUGES (PG & DPG)

Applicable standard : IS:3602-1966, IS/3624, ASME B 40.1

Type/Construction

- 760 mm to 1.0Kg/cm² : Bellows/Diaphragm
- Above 1.0Kg/cm² : Bourdon Tube
- Suction side of pumps : Compound gauge

Materials

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- Bourdon tube : 316 SS
- Bellows : 316 SS
- Movement : 316 SS
- Case : SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere.
- Protective Diaphragm : Teflon
- Dial size : 150mm with shatter proof glass
- Scale Details : Graduations in black lines on white dial, on white dial, 270 Deg. pointer deflection scale provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller. Pointer stop for all gauges.
- Accuracy : + One (1) percent or better
- Connection - Instrument Process : 1/2 inch NPT Male Bottom
- Mounting : Local
 - : 1/2 inch NPT Male (Back entry) mounted on local gauge board.
- Enclosure Class : IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

Accessories

- 3 way needle valve/manifolds : For all gauges
- Self cleaning type : Pump and compressor discharge Pulsation dampener/snubber (SS316) lines
- Syphon : For all steam lines
- Protective separating : For fuel oil and corrosive liquid lines

Other particulars

- External Zero adjustment : For all gauges
- Safety device
- Ranges 5 to 20 Kg/cm² : Rubber blow out disc with open front construction.
- Ranges above 20 Kg/cm² : Neoprene safety diaphragm at the back with solid front construction. -
- Over range protection : One Fifty (150) percent of full scale
- Other Requirements : Movement mechanism shall be glycerin filled for oil services & vibration prone area.
 - : For Fuel oil & corrosive liquid lines diaphragm type sensors required.
 - Armored capillary of 10 M for Fuel oil & Corrosive liquid service.
 - : Contact type pressure gauges are not acceptable for interlock & protection.
 - : For condensate storage tank the pressure gauge in terms of 0-10000 mm wc or suitable range having dial size of 300mm or bigger size shall be provided.

10.2.2. PRESSURE, DIFFERENTIAL PRESSURE, DP TYPE LEVEL AND FLOW TRANSMITTERS (PT, DPT, LT & FT)

Smart Transmitters of the electronic type shall be furnished. Transmitters shall be equipped with mounting brackets suitable for a mounting in transmitter enclosures. In general, Transmitters are envisaged to be grouped at several places as to be decided during detailed engg. stage. For this purpose, suitable enclosures complete with all tubing, fittings, purge meters, loop cable trays etc. shall be provided.

Type/Construction : Sealed capacitance/ Inductance/ Silicon resonance type

Material

- Body : Die cast Aluminum with epoxy coating for air & SS316 for in other area
- Diaphragm : 316 SS

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- Measurement element : Teflon seal
- Valves : Carbon steel for non-corrosive Applications SS316 for corrosive applications.

Output signal : 4 to 20 m Amp. DC (Two wires) HART Compatible
Local Indicator : LCD indicator (5 digit) with scale of Engg. unit
Overall Accuracy : + 0.065% or better of Span for BOP packages
+ 0.2% or better of span for remote seal type transmitter.

Turn down ratio : 100:1 in general
Stability : + 0.15% of URL for 5 years.
Response time : 150 msec.
Power supply : 24V DC nominal
Drive capability : 600 Ohms nominal
Enclosure Class : IP-65 (Explosion proof for NEC Class-1, Division 1 area)
Span and Zero : Locally adjustable, non-interacting
Zero suppression / elevation : At least 100% of Span

Connection

- Process : 1. Half (1/2) inch NPT (F) Quarter (1/4) inch NPT with/without oval flanges
- Electrical : Suitable for Plug in type connection (Both side of transmitter), unused entry with blind plug.

Accessories :

- For Absolute Pressure Transmitters: Two (2) valve SS316 manifold
- For Gauge & Vacuum : Three (3) valve SS316 manifold pressure transmitter
- For DP, level & flow : Five (5) valve SS316 manifold transmitter
- For oil and corrosive : Separator diaphragm seals liquids
- For all transmitters : Mounting bracket

Manifold should not be mounted on the transmitter, Manifold shall be non integral and standalone type. Snubbers/Pulsation dampers shall be used where the process media is unstable for measurement such as the discharge of a pump. Over range protection shall be used where necessary. The coil syphons & condensate pots shall be used for steam services. Transmitters shall be provided with suitable drain & vent points.

10.2.3. TEMPERATURE TRANSMITTERS

Type : SMART type configurable from control room through HART protocol (HMS System).
Display type : Indicating type (5 digit LCD Display),
Accuracy : +0.10%,
Ambient temperature error : 0.1% per 10°C change
Output : 4-20 mA DC (2 wire system) HART compatible signals for analogue monitoring inputs to the distributed control system (DDCMIS), DCS & PLC.
Protection class : NEMA 4/IP66 or equivalent degree of protection for enclosure)/
(Explosion/Flame proof for NEC Class-1, Division 1 area)/ flame proof IEC-79.1,
Part I). As applicable).
Material of accessories : SS316.
Stability : + 0.1 % or + 0.1 deg C of reading (whichever is great) for 2 years in case of RTD inputs and for 1 year in case of Thermocouples inputs.
Operating Voltage : 16 – 48 V DC

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Calibration : as per NIST monograph 125 for T/C & European Curve Alpha = 0.00385 for RTD .
 Ref. Junction compensation : Provided
 Span/zero adjustment : Locally adjustable, Non interacting
 Auto calibration : Provided
 Burn out protection upscale : Provided
 Input - output isolation : Provided
 Circuit ungrounded : Provided

Any RTD & Thermocouples shall be directly wired to DDCMIS/DCS/PLC for metal temperature application, bearing & winding temp application only.
 The Temperature transmitter shall accept Universal dual inputs of all types of thermocouples & RTD, 0-5V input signals etc.
 Temp. Transmitter shall be extremely stable against Ambient temp variation, The accuracy figure shall be inclusive of effect due to ambient temperature variation.

10.2.4. FLOW MEASUREMENT SYSTEM (PADDLE WHEEL TYPE)

Flow Sensor

- a) Type : Paddle Wheel, On-line.
- b) Installation fitting Type : Saddle / Strap on fitting depending on line size.
- c) Sensor Length : To suit the pipe line size
- d) Cable Length from sensor to transmitter : Min 5m

Transmitter

- a) Type : 2 wire type, with separate remote mounted display unit.
- b) Scale range, Cu.m./ Hr : As per process requirement.
- c) Mounting : Skid/Wall mounted type. Suitable mounting accessories to be offered.
- d) Protection : IP 55, weather proof.
- e) Power supply : 24 V DC +/- 10%
- f) Accuracy : $\pm 1\%$ of full scale.
- g) Output Signal : 4-20mA DC

Mounting bracket shall be supplied for Pipe / Rack mounting of the indicator.
 The upstream & downstream straight length requirements for the flow sensor shall be indicated in the offer.
 c) Calibration test to be done for Sensor & Indicator and T.C to be furnished.

10.2.5. ELECTROMAGNETIC FLOW METER

Electromagnetic flow meters shall have separate transmitter having accuracy +0.2% with zero stability feature, suitable for process medium with ≤ 5 micron Siemens conductivity, flanges material SS-316, electrode & measuring tube material SS-316, liner material Teflon and enclosure IP-66, local digital display configurable as totaliser, 4-20 mA output signal HART compatible with zero and span field adjustable

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10.2.6. PRESSURE SWITCHES (PS) & DIFFERENTIAL PRESSURE SWITCHES (DPS)

Applicable Standards : IS3624 - 1966/ISA-RP-8.1 except as modified in spec.

Type/Construction : Bourdon/Sealed Diaphragm Piston Actuated preferable. Indicators with contacts are not acceptable.

Materials

- Bellows : 316 SS
 - Bourdon tube : 316 SS
 - Movement : 316 SS
 - Enclosure : Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere.
 - Protective Diaphragm : Teflon
- Accuracy : + One (1) percent or better
Repeatability : + 0.5(half) percent or better
Setting & Differential : Adjustable

Contact

- Number : DPDT /2 SPDT
 - Type : Auto reset with internal Adjustable snap action micro switch
 - Rating : 5 Amp, 240V AC / 0.2 Amp, 220V DC
- Connection - instrument : Half (1/2) inch NPT Male Process
Electrical : Suitable for Plug in type connection. All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not terminated inside the switch. Cable ends are to be soldered in connector and to be inserted for easy maintenance.
- Over range protection : One Fifty (150) percent of full scale
- Enclosure Class : IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

Accessories

- 3 / 5 valve manifold : As applicable for all switches
 - Self cleaning type : Pump and compressor pulsation dampners/Snubber discharge lines
(Material SS316)
 - Syphon : For all steam lines
 - Protective separating : For fuel oil & corrosive liquid lines. diaphragm
- Mounting : Local (in LIE/LIR for BTG package).

10.2.7. DIRECT MOUNTED LEVEL TRANSMITTERS (LT)

Displacer type level transmitter shall not be used in the process anywhere in the plant.

10.2.7.1. Ultrasonic Level Transmitter)

Principle of Operation : Detection of reflected ultrasonic pulse
Measuring Ranges : Up to 30 meters (typical)
Signal Processing : Microprocessor Controlled Signal Processing
Operating Freq. : 10 KHz to 50 KHz (typical)
Display : Head mounted alpha-numeric back lit

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LCD/LED

Calibration & Configuration : Accessible from front of panel & HART calibrator.

Diagnosis : On-line

Status : For power, Hi / Lo / V. Hi / V. Lo-level indication, fault etc.

Construction : Plug-on board

Power supply : 240 V AC 50 Hz / 24V DC

Signal Output : 4-20 mA DC with HART (isolated) - 600 Ohm load.

Hysteresis : Fully adjustable preferred

Output contacts : 2SPDT Potential free changeover contacts @ 8A 230V AC.

Accuracy & Repeatability : + 0.25% of span or better

Resolution : + 0.1% of span

Temperature Compensation: To be provided with Transducer.

Operating temp. : Transmitter-50 deg C and Sensor – 80 deg C

MOC Sensor : Body- PVDF and Face – Polyurethane

Humidity : 1% to 95% non condensing.

Enclosure : IP-67 Epoxy painted die cast

Aluminum or SS316L housing.

Cable Connection : 3/4" ET

Mounting : 2" – 4" NPT or flanged

Accessories : Cable gland, prefab cable, mounting accessories like EPDM seal, SS316 flanged etc.

Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during detailed engineering

10.2.8. PH CELL AND TRANSMITTERS

a) Applicable Standard pH electrodes shall conform to IS: 6804-1972 except as modified in this specification

b) Type:

i) Cell Measuring and Reference Electrode Combination with Flow through type (SS316/Polypropylene flow chambers) for power plant's steam & water application. Sensor shall not be affected by flow variation. Sensor shall be designed for power plant applications.

ii) Monitors Electronic (microprocessor based) indicating type with adjustable range facility.

c) Material:

i) Measuring & reference Toughened sensitive

ii) Electrode pH glass

iii) Monitor body Carbon steel/Aluminum/Polycarbonate

d) Monitor output

i) 4-20 mAmp D.C. with HART protocol spare out put

ii) 4-20mA DC with HART protocol for DDCMIS

Output load : 500Ω

e) Power supply 240V AC, 50 Hz from UPS

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- f) Accuracy/repeatability + 0.03 pH/+0.02PH
- g) Resolution + 0.01 pH or 1 mV. 1C
- h) Stability 0.02 pH per week
- i) Annunciation contacts from monitors:
 - i) Number 2 SPDT 'Hi' and 'Lo'
 - ii) Type Snap action micro switch
 - iii) Rating 5 amp, 240V AC, 0.2 Amp, 220V DC
- j) Connection:
 - i) Process One-quarter (1/4)inch NPT(F) SCRD ON-LINE
 - ii) Electrical Half (1/2) inch NPT(F) SCRD
- k) Mounting:
 - i) Cell Pipe Mounted
 - ii) Monitors Flush panel mounting
- l) Accessories
 - i) Automatic temperature compensation with fast response integral temperature sensors in the range 0-100°C
 - ii) Co-axial cable as required
 - iii) Sample coolers
 - iv) low and pressure regulators
 - v) Standard pH solutions
 - vi) SS316 impulse tubing and fittings
 - vii) Isolation & drain valves as required
 - viii) Electrode holders
 - ix) Other accessories as required
 - x) Sample rate set valves
 - xi) Alarm settings and indications on monitor.
 - xii) RFI/EMI shielded, weather and corrosion proof casing

10.2.9. CONDUCTIVITY ANALYSER

Applicable standard ASME PTC 19.11-1970 except as modified in this specification.

Type:

- i) Cell Flow through type/ removable type (withdraw able with sealing valve)
- ii) Monitors Electronic (Microprocessor based) indicating type with multi range facility

Material :

- i) Cell Epoxy resin/SS316
 - ii) Electrode Platinised/SS316
 - iii) Monitors body Carbon steel/Aluminum/Polycarbonate
- Monitor output i) 4-20 mA D.C. with HART protocol spare out put
 ii) 4-20mA DC with HART protocol for DDCMIS
- Output load : 500Ω
- Power supply 240V, AC, 50 Hz from UPS
- Accuracy + 1% of full scale span
- Stability + 1% of full scale per month non-cumulative
- Repeatability + 0.3% of span

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Annunciation contacts from monitors i) Number 2SPDT

ii) Type Snap action micro switch

iii) Rating 5 amp, 240 V, 0.2 Amp, 220V DC

Connection: i) Cell- On line/pipe mounted (ON LINE in sample table) 1/4 (Quarter) inch NPT (F) SCRD for on-line type and Three quarter (3/4) inch NPT (M) SCRD for pipe mounted.

ii) Monitors flush panel mounting

Electrical Half (1/2) inch NPT (F) SCRD

Accessories i) Automatic temperature compensation in the range 0-100°C

ii) Ammonia (NH₃) removal equipment.

iii) Sample coolers

iv) Flow and pressure regulators

v) SS316 impulse tubing and fittings

vi) Isolation & drain valves as required

vii) Other accessories as required

viii) Adequate length of cables for connecting coils to monitors

ix) Sample rate set valves

x) Alarm settings and Alarm indications on monitor.

m) Other particulars Cell shall be suitable for maximum pressure of 7 kg/cm²

n) Response time < 3 seconds

10.2.10. TURBIDITY ANALYSER

Sensor

Reference type : On Line

Operating principle : Alternating Light Source

Cleaning : Self Cleaning

Electrode holder – type : Flow Through

Body Material : CPVC

Process Connection : ½” NPT (F)

Pre Amplifier : Built-In

Transmitter

Type : Microprocessor Based

Transmitter Output : 4-20 mA DC

Enclosure Protection : IP65

Enclosure material : polycarbonate

Electrical connection : ½” NPT (F)

Local Indicator : Provided (LCD Display)

Accuracy : 0.2 NTU or ± 2% of reading

Repeatability : ± 0.1% of span

Temp. compensator : built-in

Cable between transmitter & sensor : To be provided

All analysers shall be supplied with chemicals/regents required for 12 months operation. Bidder shall also provide start up kits, buffer solution for pH and conductivity analyzer. The analyser supplier shall submit the preparation procedure / formula of the reagent to be used in analyser solution.

10.2.11. ORP ANALYSER

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Sensor (Electrode) :

Installation : Mounted on bypass line. Flow through chamber or Tee to be offered for bypass line installation.

Measuring Electrode : Double junction, combined electrode housed in tough, corrosion proof body.

Preamplifier : Integral with the sensor.

Wetted Parts : Bidder to select suitable for the medium.

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

Sensor to Indicator Cable Length : 10 Mtrs.

Analyser :

Type : Microprocessor based

Scale Range : +/-1500 mV

Mounting : Wall / Panel / Pipe mounted type

Protection Class : IP 65, weather & water proof

Display : LCD / LED with alarm status and

Indications.

Calibration : Calibration with standard buffer solution/powder.

Accessories : 2 Adjustable set points

Output Signal : Isolated 4-20 mA DC linear signal.

Enclosure : Corrosion proof enclosure.

Performance:

Accuracy % FSD : +/-1 mV

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

Cable Termination : Terminal block to suit 2.5 sqmm wires.

10.2.12. Technical Specification of Silica Analyzer (SI OX)

- | | |
|---------------------------|---|
| a) Applicable standard | ASME PTC 19.11-197 except as modified in this specification |
| b) Type Multi Channel | Three channel
Colorimetric Analyzer (with auto reagent shut off feature in case of sample loss or power loss) built in phosphate inhibition feature. Microprocessor based. |
| c) Material: | |
| i) Case Die cast aluminum | |
| d) Cycle/Response Time | Twelve (12) minutes Maximum |
| e) Analyser output | i) 4 to 20 m Amp DC for spare output
ii) 4 to 20 m Amp DC Isolated output for DCS/PLC |
| f) Power supply | 240V AC, 50 Hz from UPS |
| g) Accuracy | + 1% of span |
| h) Repeatability | + 2% of full scale |
| i) Sensitivity | 0.2 micrograms/liter |
| j) Connection: | |
| i) Process | Quarter (1/4) inch NPT(F) SCRD |

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ii) Electrical	Half (1/2) inch NPT (F) SCRD
k) Ranges	As per sample stream detail table
l) Mounting	Flush
m) Annunciation contacts:	
i) Number	2 SPDT
ii) Type	Snap action micro switch
iii) Rating	5 amp 240V AC 0.2 Amp 220V DC
n) Accessories	i) Automatic temperature compensation
	between 5 to 50 deg C
	ii) Automatic zeroing provision
	iii) SS316 tubing & vessels
	iv) All chemical reagents for 12 months operation
	of the analyzer
	v) Sample rate set values
	vi) Comprehensive diagnostic and alarm features.
	vii) Auto sampling facility with necessary valves & solenoids in the sample lines shall be provided.

10.2.13. Technical Specification of Chloride Analyzer

i) Type	Microprocessor based Continuous flow
	through sample type.
ii) Analyzer power supply	240V AC, 50 Hz, Single Phase from UPS
iii) Analyzer output	i) 4-20 mA, DC spare output
	ii) 4-20 mA, DC isolated output for DDCMIS
iv) Accuracy	Better than +10 % of full scale
v) Sensitivity	Better than 1 ppm
vi) Range	As per Requirements.
vii) Annunciation contacts:	
- Number	As per schedule, 2 SPDT
- Type	Snap action micro switch
- Rating	5A, 240V AC, 0.2A, 220V DC
- Mounting	Flush
viii) Terminal points	All components piped & wired to terminal points
ix) Accessories	i) Flow regulator
	ii) Flow gauges
	iii) Sample rate set valves
	iv) Other accessories as required to make the system complete

10.2.14. Technical Specification of Sodium Ion Analyzer

i) Type	Microprocessor based Continuous flow through
	sample type with sodium responsive
	electrode and reference electrode having pH
	adjustment facility (3 streams)
ii) Case material	Die-cast aluminum/SS/Polycarbonate
iii) Analyzer power supply	240V AC, 50 Hz from UPS
iv) Analyzer output	i) 4-20 mA DC for spare output
	ii) 4-20 mA DC isolated output for DDCMIS
v) Accuracy	Better than + 5% of full scale
vi) Response Time	6 minutes. max
vii) Sensitivity	0.1 ppb
viii) Annunciation contacts:	
- Number	2 SPDT

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- Type Snap action microswitch
- Rating 5A 240V AC, 0.2A, 220V DC
- Mounting Flush

ix) Terminal points
x) Accessories

All components piped & wired to terminal points
i) Flow regulator
ii) Flow gauges
iii) Sample rate set valves
iv) Other accessories as required to make the system complete
v) Chemical reagents as applicable for 12 months consumption

10.2.15. Non - Nucleonic (Vibration) Type Density Meter (For DM Plant):-

Application :
Detector

Liquid Density measurement

- Orientation : As per requirement.
- Case Material : SS 316/ Cast Aluminium alloy
- Wetted part material : SS 316
- Operating Principle : Vibration Density measurement

Convertor

1. Output : 4-20 mA DC isolated.
2. Electrical Connection : ½" NPT
3. Enclosure Class : IP 65
4. Local Display : Digital 5 digit, density display with temp. compensation.
5. Accuracy : +/- 1%
6. Response time : < 1 minute.
7. Power Supply : 240 V AC, +/- 10%, 50 Hz. From UPS

10.2.16. RESISTANCE TEMPERATURE SENSORS WITH THERMOWELLS

Applicable Standard : ASME PTC 19.3 - Latest Revision DIN EN 60751:1996, BS EN/IEC60751: 2008

Element : Platinum, R0=100 ohm 4-wire Duplex for Process Temp. Measurement
Platinum, R0=100 ohm 3-wire

Duplex for Bearing & Winding Temp. Measurement

Sheath Material/ Insulation : 316SS/Compacted Magnesium Oxide

Sheath O D : 8 MM

- Gauge : 18 AWG

Terminals : Spring loaded high temperature ceramic base with silver plated brass for high vibrating locations.

Calibration : As per DIN Standard – 43760, Class A

Head : Hex Head, Die Cast Aluminum (Screwed) with galvanized SS chain

Response Time : 6-10 Sec bare & 30 Sec. With protective sheath/thermowell

Accuracy : + 0.35 degree C or Class-A whichever is better.

Electrical connection : Gold plated Plug in type. Double entry – one unused entry with blind plug

Enclosure Class : IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

10.2.17. THERMOWELL

Applicable Standard : ASME PTC 19.3 TW - 2010

- Construction : Tapered drilled from Bar stock (Straight for Air & Gas systems)

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- Material : - 316 SS/F11/F22/F91 - water and steam Services depending upon process parameters.
- Inconel for air & flue gas services For furnace zone, impervious ceramic protecting tube of suitable material along with Incoloy supporting tubes and adjustable flanges. For Mill classifier outlet long life solid sintered tungsten carbide material or better of high abrasion resistance. Bidder shall provide calculation for thermowell as per ASME – PTC-19.3 2010. “All Thermowells in high velocity steam service shall be checked for Strouhal’s frequency limit to arrive at a safer size and design of Thermowells”.
- Process Connection : (i) M 33 x 2
(ii) SS316 Flanged, for Air & Gas systems, with mating flanges, fasteners, gaskets etc.
- Extension : Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends

Immersion length : Within + 10 mm of center line of pipe and as per ASME – PTC-19.3 - 2010

Extension neck length : Minimum 100 mm above insulation of pipe and Minimum 160 mm when there is no insulation on pipe.

IBR Certification : For high pressure service, Steam Temp., Fuel oil temp. Measurement as per IBR rules and regulations

Note : Extension /Compensating/paired cable exposed to atmosphere in the conventional method melts away due to high temperature at the top of mill or due to coal burning. Hence The terminals of temperature sensors shall not be at the top of mills itself. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB.

Note : Extension/Compensating cable exposed to atmosphere in the conventional method melts away due to high temperature at the top of mill or due to coal burning. Hence The terminals of temperature sensors shall not be at the top of mills itself. The temperature sensors wires are to be laid up to JB though Duplex SS/SS 316 tube of required diameter and the head shall be placed nearer to the JB.

10.2.18. TEMPERATURE GAUGES (TG)

Applicable standard : IS : 3602,BS:5235 ISA:RP:8.1 except as modified in this specification

Type/Construction

- Thermometer : Industrial type, Gas in Filled type with separable thermowell
- Thermowell : Bar stock

Material

- Bulb : 316 SS
- Capillary : Armoured SS (Applicable for capillary Type)
- Casing : SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere
- Dial Size : 150mm with shatter proof glass
- Scale Details : 270 degree dial rotation/deflection. Graduations in black lines on white dial provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller .Pointer stop for all gauges

Accuracy : + One (1) percent or better

Response time : Maximum 15 seconds without thermowell and 30 seconds with thermowell

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Connection

- Pipe : M33 x 2
- Thermowell : To suit instrument with same design criteria specified for RTDs.
- Process Connection : (i) M 33 x 2
(ii) SS316 Flanged, for Air & Gas systems, with mating flanges, fasteners, gaskets etc.
- Extension : Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends

Other Particulars

- Capillary length : 5Meters/10 Meters as required
 - Immersion Length : Within + ten (10) mm of center line of pipe with adjustable nuts.
 - Extension neck length : Minimum 50 mm above insulation of pipe /As per approved hookup drawings.
 - Stop at Maximum value : For all gauges of scale
 - Pointer : Externally adjustable
 - : In general, Contact type Temp. gauges are not acceptable for interlock & protection. Contact type Temp. gauges are acceptable for interlock & protection in case of bearing temp. only.
 - Over range protection : 150 percent (%) of full scale
- Enclosure Class : IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
- IBR Certification : For high pressure service, Steam
- Temp., Fuel oil temp. measurement as per IBR rules and regulations

All water analyzer's monitors installed in the field shall be mounted in the enclosures to protect from direct sun light , water & dust. Water analyzers shall be able to sustain the ambient conditions at site. Necessary Enclosure shall be supplied by bidder along with analyzers

11. INSTRUMENT AIR SYSTEM

The instrument Air Supply System for various pneumatic Control & Instrumentation devices like pneumatic actuators, power cylinders, I/P converters, pneumatically operated valves etc. shall be complete in all respect with necessary Air Filter Regulators, valves, piping/tubing etc.. Each pneumatic instrument shall have an individual air shut off valve. The pressure-regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built in filter-housing blow down valve.

Filter shall be of minimum 5-micron size & sintered bronze material. On collection of water in the drains of instrument air lines, mechanical automatic drains and periodically solenoid operated drains (with electronic timer - 15m, 30m, 60m and 2 Hours & Timing adjustable) are to be provided.

For mechanical type & Electrical type, the locations to be provided in the instrument air lines shall be decided during detailed Engineering.

Bulk header nearby the crowded applications shall be provided and from this bulk header individual air lines with necessary isolation valves are laid to the application. These bulk header are to be provided with mechanical / electronic based automatic Drains.

Individual moisture separator for O2 analyzer or vital application shall be provided nearby the instrument so as to enhance the cell life or the performance of vital final control elements.

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12. AIR FILTER REGULATOR (AFR)

Constant bleed type AFR with an accuracy of + 1.0 % inlet pressure range of 5-8 kg/ cm² and suitable spring ranges (AFR) for use with positioners in control valves, control damper, E/P convertors and shut off valves for phosphor bronze filter element; Filtering particles above five microns. Weather and water proof enclosure. Material of accessories will be DUPLEX SS / SS316.

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 convertors.
- (c) Air supply line to pneumatic interlocked block valves.
- (d) For each instrument rack, field instruments enclosure for purging.

13. ELECTRO-PNEUMATIC CONVERTORS (E/P)

Two wire type E/P convertors with an accuracy of +0.25% accepting 4-20 mA dc signals from control system and converting to 0.2 to 1 kg/cm² air pressure to operate valve positioner of all final control elements; Housed in cast aluminum casing (with polyurethane paint); NEMA 4 or equivalent degree of protection for enclosure. Material of accessories will be SS. E/P convertors shall have fail freeze (stay put) feature also. Process connection shall be 1/4" NPT (F) and Electrical connection shall be 1/2" NPT (F). Zero/span adjustment facility shall be provided. The E to P convertors shall retain the pneumatic signal (last value) even in failure of control signal and shall have self-volume boosters. Necessary air lock devices and pressure switches for air pressure low alarming shall be provided.

14. SOLENOID VALVES

Solenoid valves shall be provided with control valves / pneumatic control valves hooked up with process interlock requirements and where direct tripping is involved. The number of ways for solenoid valve shall be provided as indicated below:

- (a) Two (2) way solenoid valves shall be provided, where process line of less than 50 mm with low pressure and temperature application.
- (b) Three (3) way solenoid valve shall be provided commonly, where the pressure is admitted or exhausted from a diaphragm valve or single acting cylinder, e.g, Pneumatic operated spray water block valve.
- (c) Four (4) way solenoid valve shall be provided for operating double acting cylinders, e.g, Pneumatically operated on-off type dampers.
- (d) For operation of the fuel oil corner nozzle valves, fuel oil trip valves etc., double coil solenoid valve (latch coil & relatch coil) shall be adopted. Single coil usage requires always power and loss of power leads to closure of above valves resulting the unit trip or loss of generation.
- (e) Solenoid Valve coils shall be Class-H high-temperature or Class-F construction as applicable and shall be designed for continuous duty. Three-way solenoid valves shall be designed for universal operation so that the supply air may be connected to any port. Solenoid enclosures shall be NEMA-4/ (Explosion proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I) As applicable). Body material of solenoid valve shall be Die Cast Aluminum / SS316.

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(f) All solenoid shall be with varister, LED indication, surge suppress diode and circuits.

15. Deleted.

16. CONTROL VALVES, ACTUATORS AND ACCESSORIES

16.1. GENERAL REQUIREMENTS

This section covers the design and construction requirements of Control Valves, their Actuators and Accessories. Except as otherwise specified herein, the Control Valves and accessory equipment furnished under this specification shall be designed, constructed and tested in accordance with the latest applicable requirements of code for Pressure Piping ANSI B31.1, the ASME Boiler and pressure vessel code, Indian Boiler Regulation (IBR) and other standards referenced herein as well as in accordance with all applicable requirements of the "Federal Occupational Safety and Health Standards, USA", or acceptable equal standards.

The design of Control Valves shall comply with relevant codes and standards, account for relevant design criteria viz. environmental conditions, power and air supply, established reliability (reliability target and life expectancy), design of enclosures as specified in Sections earlier.

All Control Valves and accessories furnished under the Section shall be of Owner approved make, fully meeting the qualifying requirements.

Each control valve station shall be provided with pneumatic bypass control valve or Inching type motorised bypass valve as per process requirement and subject to owner approval. In addition each control valve shall also have upstream motorised valve. Downstream motorised valve shall also be provided as per process requirement and as finalized during detailed engineering.

16.2. CONTROL VALVE CONSTRUCTION AND SIZING

16.2.1. General

1. Valve Construction shall be in accordance with the requirements specified herein. (Bidder to also refer NIT drawing # 114-18-0100).
2. The design of all valve bodies shall conform to the requirements of ANSI (USA) for dimensions, material thickness and material specification for their respective pressure classes.
3. The valve sizing shall be suitable for obtaining maximum operating conditions with valve opening at approximately 80% of total travel. Valves shall be open not less than 15 % of full opening for minimum flow condition and shall be capable of handling at least 120% of the required maximum flow at full open condition. Actual pressure drop is indicated in the specification sheets. Permissible pressure drop shall be calculated and used by the Bidder for sizing calculations. Valve sizing shall be in compliance with the latest edition of ISA Handbook on control valves, ISA standards "ANSI/ISA-75.01.01, Flow Equations for Sizing of Control Valves" with due consideration for the measures to avoid choked flow. Bidder shall ensure that the valve outlet velocity does not exceed 8 meters/second for liquid services, 150 m/second for steam services and 50% of sonic velocity for flashing services by selecting proper body size for the required Cv.
4. The Bidder shall provide valves designed to prevent cavitations, wire drawing, flashing on the downstream side of valve and in downstream piping, when operating through full range under the specified conditions.

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For cavitating services, valves with anti cavitation trims shall be offered. This shall ensure cavitation prevention by multiple stages of pressure drops. Detailed calculations shall be furnished by bidder to establish cavitations occurrence or otherwise for various process conditions each service wise.

For flashing services such as heater drains, control valve design shall be specially effected to ensure suitability for the adverse high pressure drops and minimise its detrimental effects on control valve parts.

Bidder shall furnish detailed catalogue, calculations, write ups to establish compliance to these stipulations with the selection of each valve. No price implications during engineering stage would be admissible to comply with these stipulations and intents of specification.

b. The Liquid pressure recovery factor (FL) shall be 0.995 or better for severe flashing/cavitation services.

c. The Liquid pressure recovery factor (FL) shall be 0.985 or better for low flashing/cavitation services.

5. Each valve shall be designed for tight shut-off against pressure, the valves shall have maximum permissible leakage rate as per ISA RP 39.6 Leakage Class IV (0.01% of rated valve capacity) or specified otherwise.

6. The valve design shall take into account noise abatement considerations. The design objective will be to limit the generation of valve induced noise to 85 dBA at 1 Meter from the valve surface under actual operating conditions. The noise abatement shall be obtained by valve body and trim design and piping arrangement and not by the use of silencers.

7. The Bidder shall be responsible for proper sizing of the valve and selection of appropriate model and materials of constructions for meeting the operating requirements specified herein and details subsequently furnished during the detailed engineering stage.

8. The valve travel time shall be less than 10 second for non critical services valves.

9. Rangeability should be 50 to 1 (min.) for non critical services valves.

10. Control Valve's Linearity, Hysteresis, Accuracy shall be < +1% and Sensitivity shall be < + 0.5%.

Bidder shall furnish the Control Valve data sheets and sizing calculations with the proposal which will be subjected to owner approval during detailed engineering. The bidder shall furnish all valves as per Owner approved data sheets and drawings.

Other associated specifications for the plant/system shall also be referred in this regard.

16.2.2. Valve Construction

16.2.2.1. All valves shall be of globe body design and straightway pattern. Straightway pattern valves shall be either single or double ported as specified. Double ported and single ported valves shall have high lift cage guided plugs, unless otherwise specified.

16.2.2.2. Where specified, valves with cage guided plugs and quick change trim shall be supplied. The quick change trim shall consist of a cage and seat ring clamped in the valve body by the valve bonnet and sealed with a spiral wound stainless steel asbestos gasket. The trim shall be removable through the top after bonnet removal without any cutting or welding of the valve. Where applicable, plugs shall be designed to include pressure balancing for cage guided valves.

16.2.2.3. Direct acting and self-contained pilot type valves may have low lift plugs.

16.2.2.4. Cast iron valves are not acceptable.

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- 16.2.2.5.** Bonnet joints for all control valves shall be of the flanged and bolted type or other construction acceptable to the Owner. Bonnet joints shall be designed for easy disassembly and for assurance of correct valve stem alignment. Bonnet joints of the internal threaded or union type will not be acceptable.
- 16.2.2.6.** Plugs shall be of one-piece construction either cast, forged, or machined from solid bar stock. Plugs shall be screwed and pinned to valve stems or shall be integral with the valve stems.
- 16.2.2.7.** When Teflon packing is used, the lower valve stem which passes through the stuffing box shall be polished to at least 2×10^{-4} millimeters r.m.s.
- 16.2.2.8.** Valves gland packing shall normally be Teflon on liquid and gas services up to 100kg/cm² and 230 Deg.C Teflon impregnated asbestos shall be used above 230 Deg.C and graphite impregnated asbestos with lubrication shall be used for steam services.
- 16.2.2.9.** All valves shall be arranged so that the plugs may be removed from the valve bodies from the bonnet side.
- 16.2.2.10.** Each valve shall have an arrow permanently fixed on the valve body to indicate the correct direction of flow.
- 16.2.2.11.** Each valve shall have a stainless steel name plate permanently fastened to the yoke which shall be visible when the valve is in service. The name plate shall include
- Tag No. and Valve Serial No.
 - Body material, size and pressure rating
 - Trim material, size characteristics
 - Action on air failure
 - Spring range
 - Stem travel
 - Valve action, etc.
- 16.2.2.12.** Body material shall be selected by the Bidder to be compatible with the nature of the fluid, service conditions, and piping material to which it is welded and shall be subjected to Owner approval. In general, cast or forged carbon steel bodies shall be provided for non-corrosive process applications up to 275 Deg.C. Alloy Steel castings shall be provided when the media is non-corrosive and the temperature exceeds 275 Deg.C and is within 550 Deg.C. Stainless Steel of suitable grade shall be provided when media is corrosive and the temperature is below 300 Deg.C. In DM water application cast type 316 SS ASTM A351 Gr CF8M shall be used.
- 16.2.2.13.** Unless otherwise specified, all control valves shall have stems, guide bushings, plugs, seat rings, stem lock pins, stuffing box parts, and other trim, all made of stainless steel. Valve guide posts and bushings shall be stellite faced for valves where specified. Stellite faced guide posts and bushings shall be differential hardened. For applications involving high pressure drop as also for flashing and cavitation services, trim material shall be properly chosen to ensure required degree of hard facing (such as 17-4 PH SS) so as to avoid erosion.

16.2.3. End Preparation

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1. Valve body ends shall be butt-welded type.
2. Flanged ends shall be of a pressure class equal or greater in pressure-temperature rating to the body design pressure and temperature indicated on the control valve. Unless otherwise specified, steel flanges shall be raised face type. Flanged ends for valves shall be in accordance with ANSI B 16.5.
3. Welded end for control valves where specified shall be socket-weld per ANSI B 16.11 for control valves of sizes 50 mm (2") and below and Butt welded connections per ANSI B16.25 for control valves 65 mm (2-1/2") and above. The end preparation for butt welded control valves shall be matched to the corresponding details for the piping on which the valve is installed.
4. All end preparations shall be as per Owners requirements indicated during Contract stage.

16.2.4. Miscellaneous Parts

1. Extension bonnets shall be used on all valves when the maximum temperature of the flowing fluid is greater than 275 deg. C or when specifically required in the control valve.
2. Stem travel indicators shall be provided on all valves.

16.3. VALVE OPERATIONS

All control valves shall be furnished with pneumatic spring opposed diaphragm, spring less diaphragm, or piston operators as specified herein.

The bidder shall be responsible for proper selection and sizing of valve operators in accordance with the pressure drop and maximum shut-off pressures.

Valve operators and stems shall be adequate to handle the unbalanced forces occurring under the specified flow conditions or the maximum differential pressure specified. An adequate allowance of stem force, at least 0.15 kg/sq. cm per linear millimeter of seating surface, shall be provided in the selection of the operator to assure tight seating unless otherwise specified. The operators shall be designed to produce the required stem force with supply air pressure of 3.5 kg/sq. cm maximum unless otherwise specified.

Diaphragms shall be moulded synthetic rubber and diaphragm housing shall be of pressed steel construction. Diaphragms shall not be fabricated of natural rubber.

Piston operators shall use cast pistons and cylinders with O-ring seals. Operators shall be supplied with name plates which indicate the diaphragm air pressure at full open and full closed positions. for single seated valves the pressures shall be listed for maximum differential and for zero differential across the valve.

Pistons and cylinders shall be cast aluminum. Piston rod and extension shall be chrome plated stainless steel. Cylinder seal bushings shall be brass and seal rings shall be nitrile. Yoke shall be cast iron.

Valve operators shall be capable of operating at 60 °C continuously.

16.4. CONTROL VALVE ACCESSORIES & DEVICES

The following accessory equipment shall be provided for control valves:

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16.4.1. Air Locks: Air locks shall be designed to shut off the diaphragm loading air line if the supply air pressure to the associated pilot or Positioner fails. Air locks shall be of the automatic reset type and shall be furnished with alarms.

16.4.2. Hand Wheels: Hand Wheels shall be provided. Hand wheels shall be side mounted unless specified to be top mounted. However the mounting shall be as decided during engineering to offer maximum accessibility.

16.4.3. Limit Switches: Each control Valves shall be provided with limit switches for monitoring of end position in DDCMIS/DCS/PLC. Switches shall have not less than two normally open and two normally closed contacts in both open and close directions. Electrical rating of the limit switch contacts shall be 240V AC, 5 amp or 220V DC, 0.5 amp. Limit switches should be National Acme Co., or Honeywell micro switch type or Owner approved equal. The enclosures of the limit switches shall be as per NEMA-4 Standard. Limit switches shall be constructed to withstand the temperatures encountered in the actual service. Explosion proof construction shall be furnished where required by applicable code or these specifications. Limit switches shall be factory mounted on the valves with provisions for adjusting the mounting. The Bidder shall stroke the valves to check limit switch operation prior to shipment.

Limit/micro switches can be offered as an integral part of Smart valve positioner.

16.4.4. Smart Valve Positioner: Control valve actuators for modulating and throttling services shall be provided with HART protocol based smart electro pneumatic valve Positioner to ensure accuracy & repeatability of response. The valve Positioner shall be designed suitable for vibration and service conditions of a steam electric power station.

The Positioner shall have the following features:

- a) Shall provide a pneumatic output signal of range 0.2 to 1.0 kg/cm² or as desired for the actuator.
- b) Shall have integral type position transmitter, input & output gauges, local keypad, display, 4-20 mA input and 4-20 mA output (with feedback card) for position indication in DDCMIS/CCR/PLC.
- c) Shall be suitable for direct mounting on control valve assembly both for rotary & linear valves.
- d) Shall be capable of functioning under hot, humid & vibrating conditions.
- e) Shall have dust tight, corrosion resistant & weather proof IP 65 metal casing.
- f) Shall be operated at signal range of 4-20 mA for full travel of the valve. Split range operation in few case may be required. This facility shall also be available in positioner.
- g) Shall have in built mechanical position indicator.
- h) Shall have fail safe & fail freeze function as per loop process requirement.
- i) Shall have in built auto tune facility.

16.4.5. Solenoid Valves: Solenoid Valve will be provided for the following

- i. ON / OFF Duty type Control Valve
- ii. For over-riding the controller signal with Modulating type Control valves.

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- iii. For control valve stay put position requirement on controller signal failure with Modulating type Control valves.
- iv. For construction and detailed specification of Solenoid valve refer specification on solenoid valves

16.4.6. Diffusers : Diffusers shall be provided as per service application requirements. The diffuser shall be designed to reduce the pressure drop across the control valve below the critical value and reduce the sound pressure level. Details of the diffusers shall be submitted.

16.4.7. External Volume Chambers: External volume chambers with adjustable bleed valves shall be provided for Control Valve. Volume chambers shall be furnished, mounted on the control valve yoke assembly.

16.4.8. Position Transmitters: Position transmitters shall be provided for control valves as a part of smart positioner. The signal shall be 4-20 mA DC range, 24 V DC. For non smart positioners applications and power cylinders, contact less position transmitter shall be provided by bidder.

16.4.9. Tubing and Air Sets: All pneumatic tubing required to interconnect devices assembled together shall be furnished complete with each control valve. The tubing shall be fully annealed soft temper copper tubing conforming to ASTM B68 to B75 (USA). Swage lock flare less tubing fittings shall be used for tubing connections (Swage lock or approved equal).

Each device requiring an air supply shall be equipped with a combination filter-regulator. Devices mounted together on a valve yoke may be served by a single regulator, provided the supply pressure is satisfactory and the regulator capacity is not exceeded. Filter-regulators shall be mounted on the device served.

Filter- regulators shall be suitable for a 10 kg/sq. cm maximum inlet pressure. Filter- regulators shall have built-in housing blow down valves and a 2 inch pressure gauge. The filter shall be of size not more than 5 microns and shall be made of sintered bronze.

16.4.9.1. Pressure Switch

Pressure switch suitable for the above the pneumatic system shall be provided. The contact rating shall be 2 A for 240 AC, .2 A, 220 VDC 2 SPDT Contact. Enclosure IP 65.

16.4.9.2. I/P Converter

For non smart positioners applications and power cylinders i/p converters shall be required and owner approval shall be obtained for the use of i/p converter for such applications.

Electro-pneumatic, outdoor type, field mounted Linear. 4-20 MA DC input and 0.2 – 1.0 kg/Cm² output. Die cast aluminum casing with IP65 or equivalent enclosure class. Accuracy of + 0.5% of span or better and repeatability of + 0.5% of span or better will be provided. Easily accessible span and zero adjustment will be provided I/P converter shall be provided with all accessories

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and erection hardware. The I to P converters shall retain the pneumatic signal (last value) even in failure of control signal and shall have self volume boosters.

16.4.9.3. Separate moisture separator unit for ensuring dryness of air entering I/P as well as the power cylinder is to be supplied with each control valve and control damper.

16.5. TESTING AND COMMISSIONING:

All valves shall be tested in accordance with the quality assurance programme agreed between the owner and the bidder as specified elsewhere in the specification which shall meet the requirements of IBR and other applicable codes mentioned elsewhere. The tests shall include but not be limited to the following

Valves for high pressure high temperature applications shall be subjected to 100% radiography examination test. Results shall be owner approved prior to dispatch. All castings and forging shall be visually inspected. The casting shall be radio graphically examined. Ultrasonic examination, liquid penetration examination, magnetic particle examination etc. as applicable shall be performed as per applicable standards and codes. The mechanical and chemical testing shall also be performed in accordance with applicable ASTM material specification.

16.5.1. Non-destructive examinations shall be performed as required by ANSI B81.1 (Power Piping) and ANSI B16.34 (Steel Valves).

16.5.2. Hydrostatic Test:

ii) Valve shall be subjected to hydrostatic shell test in accordance with ANSI-B16.34 prior to seat leakage test. If the valves are reworked on the pressure parts for any reason after hydrostatic test, they must be retested.

iii) Valves shall be hydrostatically tested in manufacturers works in accordance with code requirements. All hydrostatic testing and inspection shall be completed before any paint is applied to valve body. Certificates of inspection shall be executed in accordance with the latest codes and required codes shall be forwarded to the engineer.

All gaskets used for test shall be of the same material and design as specified for the finished product. Where mechanical gasket joints are broken following tests, new gaskets shall be furnished with the equipment, and the joints shall be retested.

16.5.3. Leakage Test:

i) Unless otherwise noted in the specification sheets, valve closure test and seat leakage tests shall be performed in accordance with ANSI B16.104, Leakage Class II/class IV as the case may be.

ii) The leakage from packing shall be zero or bubble tight. For valve designs which are not covered by ANSI B16.104, the bidder shall submit the expected leakage rate with his proposal for review by Owner / Technical Specialist.

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iii) If valves are disassembled after the completion of the valve closure and seat leakage tests, these tests shall be repeated.

16.5.4. Hysteresis Test :

The hysteresis test shall be run on completely assembled valves. The stuffing box shall be fully packed and made up hand tight. The allowable value of hysteresis specified by the bidder shall be achieved.

16.5.5. Tests for special class valves:

All valves supplied with the special class ratings per ANSI B16.34 “Steel Valves” (except flanged valves) shall be subject to the required examinations as per paragraph 8.3 of ANSI B16.34. the acceptance criteria shall be same as these given in Annexure B,C,D and E of ANSI B16.34 for the applicable examinations expect for the following.

Magnetic particle examination of castings, the linear indication shall not exceed 3/16 inch in length.

16.5.6. Functional Tests;

The fully assembled or completed valves including the operators control devices and accessories shall be functionally tested to demonstrate the operability of the valve and the operation. This may be done by cycling the valves 3 or 4 times from open to close position. The same controller can be used to test each valve. Control valve Fl (Liquid pressure recovery factor) in operation test on completed valve (final inspection).

17. ELECTRICAL ACTUATORS WITH INTEGRAL STARTERS

The Actuators shall be integral starters along with overload relays with built in SPP (Single Phase Preventer) with provision for operation from Control room, Local and by wireless set.

17.1. General

The actuator motors shall be suitable for use on 415 Volt 3 phase 50Hz power supply. The actuator comprising motor, integral reversing starter, local control facilities and terminals for remote control and indication shall be housed within a self contained, sealed enclosure. Actuator working platforms shall be provided for maintenance purpose.

Commissioning tools shall not form an integral part of the actuator and must be removable for secure storage/authorized release. In addition, provision shall be made for the protection of configured actuator settings by a means independent access to the commissioning tool.

For some specific applications, integral starter shall also be separately mountable casting type and plug-in. Such applications shall be decided during detail engineering.

17.2. Actuator Sizing

The actuator shall be sized to guarantee valve closure at the specified differential pressure. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal. The operating speed shall be such as to give

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valve closing and opening at approximately 4 to 5 mm per second unless otherwise stated in the job specification.

17.3. Environmental

Actuators shall be suitable for indoor and outdoor use. The actuator shall be capable of functioning in an ambient temperature ranging from 10°C to 50°C, upto 95% relative humidity.

Actuators for explosion-hazardous applications shall in addition be certified Flameproof for Zones 1 and 2 (Divisions 1 and 2 Group gases).

17.4. Enclosure

Actuators shall be 'O' ring sealed, watertight to IP68 degree of protection. The motor and all other internal electrical elements of the actuator shall be protected from ingress of moisture and dust when the terminal cover is removed at site for cabling.

17.5. Motor

The electric motor shall be Class F insulated, with a time rating of at least 15 minutes at 50°C or twice the valve stroking time, whichever is more, at an average load of at least 33% of maximum valve torque.

17.5.1. Motor Protection

Protection shall be provided for the motor as follows:

- The motor shall be de-energized in the event of a stall when attempting to unseat a jammed valve.
- Motor temperature shall be sensed by a thermostat de-energising the motor in case of overheating.
- Lost phase protection
- Overload protection
- Short circuit protection by suitably rated long acting fuse.

17.6. Gearing

The actuator gearing shall be totally enclosed in an oil-filled gear casing suitable for operation at any angle. All drive gearing and components must be of metal construction and incorporate a lost-motion hammer blow feature. For rising spindle valves the output shaft shall be hollow to accept a rising stem, and incorporate thrust bearings of the ball or roller type at the base of the actuator. The design should be such as to permit the opening of the gear casing for inspection or disassembling without releasing the stem thrust or taking the valve out of service.

17.7. Hand Operation

A hand wheel shall be provided for emergency operation, engaged when the motor is declutched by a lever or similar means, the drive being restored to power automatically by starting the motor. The hand wheel or selection lever shall not move on restoration of motor drive. Provision shall be made for the hand/auto selection lever to be locked in both hand and auto positions. It should be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in hand without damage to the drive train.

The hand wheel drive must be mechanically independent of the motor drive and any hand wheel gearing should be such as to permit emergency manual operation in a reasonable time. Clockwise operation of the hand wheel shall give closing movement of the valve unless otherwise stated in the job specification.

17.8. Drive Bushing

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The actuator shall be furnished with a drive bushing easily detachable for machining to suit the valve stem or gearbox input shaft. Normally the drive bush shall be positioned in a detachable base of the actuator. Thrust bearings, when housed in a separate thrust base should be of the sealed for life type.

1.10.00 Torque and Turns Limitation

Torque and turns limitation to be adjustable as follows:

- Position setting range 2.5 to 100,000 turns, with resolution to 15 deg. of actuator output
- Torque setting 40% to 100% rated torque.

“Latching” to be provided for the torque sensing system to inhibit torque off during unseating or during starting in mid travel against high inertia loads.

The electrical circuit diagram of the actuator should not vary with valve type remaining identical regardless of whether the valve is to open or close on torque or position limit. Spare 1 NO + 1 NC Limit switch and Torque switch shall be provided in each Actuator.

17.9. Remote Valve Position/Actuator Status Indication

Four contacts shall be provided which can be selected to indicate any position of the valve. Provision shall be made for the selection of a normally closed or open contact form. Contacts shall maintain and update position indication during hand wheel operation when all external power to the actuator is isolated.

The contacts shall be rated at 5A, 250V AC, 30V DC.

As an alternative to providing valve position any of the four above contacts shall be selectable to signal one of the following:

- Valve opening, closing or moving
- Thermostat tripped, lost phase
- Motor tripped on torque in mid travel, motor stalled
- Remote selected
- Actuator being operated by hand wheel
- Position feedback has to be provided for all inching type applications. These shall be interfaced with plant DDCMIS

17.10. Local Position Indication

The actuator shall include a digital position indicator with a display from fully open to fully close in 1% increments. Red, green and yellow lights corresponding to open closed and intermediate position shall be included on the indicator. End of travel indication colours shall be reversible. The digital display shall be maintained and updated during handwheel operation when all external power to the actuator is isolated. The display shall incorporate valve, actuator and control status indication. Provision shall be made to orientate the display through increments of 90°.

Provision shall be made in the design for the addition of a contactless transmitter to give a 4-20mA analogue signal corresponding to valve travel for remote indication when required.

17.11. Integral Starter and Transformer

The reversing starter, control transformer and local controls shall be integral with the valve actuator suitably housed to prevent breathing and condensation. The starter shall be suitable for 60 starts per hour and of rating appropriate to motor size. The starter logic shall be microprocessor- based. The controls supply transformer shall be fed from two of the incoming three phases and incorporate overload protection. It

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shall have the necessary tappings and be adequately rated to provide power for the following functions:

- Energization of the contactor coils
- DC output where required for remote controls
- Supply for all the internal electrical circuits

17.12. Integral Local Control and Control Mode Selector

The actuator shall incorporate local controls for Open, Close and Stop and a Local/Stop/Remote mode selector switch lockable in any one of the following three positions: local control only, stop (no electrical operation), remote control plus local stop only. It shall be possible to select maintained or non-maintained local control.

The local controls shall be arranged so that the direction of valve travel can be reversed without the necessity of stopping the actuator.

Provision shall be made to orientate the local controls through increments of 90°.

17.13. Control Facilities

The necessary wiring and terminals shall be provided in the actuator for the following control functions:

- Open and close external interlocks to inhibit local and remote valve opening and/or closing control. Provision shall be made to configure the interlocks to be active in remote control only.

- Remote controls fed from an internal 24V DC supply and/or from an external supply rated 110V AC to be suitable for any one or more of the following methods of control:

Open, close and stop control

a) Open and close maintained or ‘push to run’ (inching) control

b) Overriding Emergency Shut-down to Close (or Open) valve from a normally closed or open contact

The following individual potential free relay contacts shall be provided in the actuator for remote annunciation to facilitate continuous monitoring of the actuator.

- Actuator in local mode
- Actuator in remote mode
- Actuator (valve) running in OPEN direction.
- Actuator (valve) running in CLOSE direction.
- Limit switch OPEN trip
- Limit switch CLOSE trip
- Actuator in local mode.
- Actuator in inching mode.
- Actuator in self-retaining mode
- Actuator power switched off /single phasing.
- Torque switch trip, thermo switch trip and overload relay trip (or close)

Automatic phase correction facility and potential free contact for annunciation of power failure shall be provided

It shall be possible to reverse valve travel without the necessity of stopping the actuator. The starter contactors shall be protected from excessive current surges during travel reversal by an automatic time delay on energization of the contactor coils.

17.14. Monitoring Facilities

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Facilities shall be provided for monitoring actuator operation and availability as follows:

Monitor (availability) relay, having one changeover contact, the relay being energised from the control transformer only when the Local/Off/Remote selector is in the Remote position to indicate that the actuator is available for remote (control room) operation.

Where required, it shall be possible to provide indication of Thermostat trip and Remote selected as discreet signals. The actuator shall include a diagnostic module, which will store and enable download of historical actuator operation and torque data to permit analysis of actuator and valve in-service performance. Data download shall be carried out without removing any covers and all shall be available locally to the actuator or remotely via telecom data transfer.

Diagnostic and configuration software shall be made available in a Lap Top PC for user.

17.15. Wiring and Terminals

Internal wiring shall be tropical grade PVC insulated stranded cable of appropriate size for the control and 3-phase power. Each wire shall be clearly identified at each end.

The terminals shall be embedded in a terminal block of high tracking resistance compound.

The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight sea land shall be provided with a minimum of 3 threaded cable entries with provision for a minimum of 4.

All wiring supplied as part of the actuator to be contained within the main enclosure for physical and environmental protection. External conduit connections between components are not acceptable.

A durable terminal identification card showing plan of terminals shall be provided attached to the inside of the terminal box cover indicating:

- Serial number
- External voltage values
- Wiring diagram number
- Terminal layout

This must be suitable for the contractor to inscribe cable core identification alongside terminal numbers.

1.18.00 Startup Kit

Each actuator shall be supplied with a start-up kit comprising installation instruction manual, electrical wiring diagram and cover seals to make good any site losses during the commissioning period. In addition, sufficient actuator commissioning tools shall be supplied to enable actuator set up and adjustment during valve/actuator testing and site installation commissioning.

1.19.00 Performance Test Certificate

Each actuator must be performance tested and individual test certificates shall be supplied free of charge. The test equipment should simulate a typical valve load, and the following parameters should be recorded:

- Current at maximum torque setting
- Torque at max. torque setting
- Flash test voltage
- Actuator output speed or operating time.

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In addition, the test certificate should record details of specification such as gear ratios for both manual and automatic and second stage gearing if provided, drive closing direction, wiring diagram number.

1.20.00 The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out.

- Measurement of insulation resistance.
- Measurement of full load current.
- Test running of the motors

18. SPECIFICATION FOR CABLE GLANDS & LUGS, JB and SVEB

18.1. Specification for Cable Glands

- a) Bidder shall provide all cable glands required for glanding the above mentioned cables both at field instrument and local control panel side, junction boxes side and at control room side.

b) Cable glands

Cable glands shall conform to BS: 6121 and be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating. Rubber components shall be of neoprene and of tested quality. Necessary cable dimensions shall be furnished to the successful contractor.

Cable glands shall be single compression for indoor use, double compression type for outdoor use. Glands for classified hazardous areas shall be double compression type flameproof and weather proof duly certified by CMRS and approved by CCE.

18.2. Cable lugs/ferrules

The cables lugs shall be conforming to IS: 8309.

Machine ferruling shall be adopted.

Cable lugs for power cables shall be Aluminium solder less crimping type suitable for aluminium compacted conductor cables.

The cable lugs for control/instrumentation/ telephone cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipments. Cable lugs shall be suitable for termination of different cross-sections of control/ instrumentation /telephone cables and shall be of following types.

- i) Copper tubular terminal end for solder less crimping to copper conductors.
- ii) Cable lugs for control cable termination shall be insulated type. These lugs shall be flat type/ring type/U type to suit the terminals provided in the pan
- iii) Pin type lugs shall not used.
- iv) Aluminium tubular terminal ends for solder less crimping of to Aluminium conductor.

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Solder less crimping of terminals shall be done by using corrosion inhibiting compound. The cable lugs shall suit the type of terminals provided on the equipment. Lugs for control/instrumentation cables shall be PVC insulated/sleeved type.

18.3. JUNCTION BOX

- Type : Weather proof
- Enclosure : IP-65
- Material : FRP (4 mm) with protective Coating
- Cable entry : Bottom or Side
- Cable glands : Double compression type – Nickel plated brass with PVC hoods.
- Mounting : Indoor/Outdoor
- No. of terminals : As required with standardization with 20% spare of each size & type.
- Terminals : Phoenix/Wago (screw less cage clamp type spring loaded)
- Grounding : Two terminals for body and shield ground
- Door : Hinged, lockable type.
- Suitable mounting clamps and other accessories shall be in scope of bidder.
- The brackets, bolts, nuts, screws, glands, lugs required for erection shall be of brass, included in bidder scope of supply. High voltage & insulation resistance test shall also be conducted.
- M6 Ni plated Brass earthing stud shall be provided (external 2 nos. internal 1 no.)
- Gasket (Normal)- Neoprene thickness 6.0 mm

18.4. SOLENOID VALVE ENCLOSURE BOX

Each variant of the SVEB shall be supplied with required no. of Solenoid Valves (SOV), Air Filter cum Regulator (AFR), tubing with necessary fittings, mounting brackets, wiring, cable glands & lugs, Terminal Blocks (TBs) etc.

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 through an AFR.

The outlet / vent connections of the solenoid valve shall also be connected using SS 316 double compression type tube fittings.

Stickers have to be fixed for the SOV to indicate tag number. Separate SS Tag plates shall be mounted with plate screws for each outgoing impulse tube .Tag numbers shall be inscribed on the SS plates. Tag number for the same will be informed during detail engineering.

Incoming line size & common header : ½” OD SS316 Tube Double compression fitting

Outgoing line size (To POVs) : ¼” OD SS316 Tube Double compression fitting

18.4.1 TECHNICAL REQUIREMENTS

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- a) Enclosure material : 2 mm Cold rolled sheet steel
- b) Material of removable gland plate: 3mm Hot rolled sheet steel
- c) Material of continuous hinge pin, rider clamp, rider spring, washers & rider bolt.: SS316
- d) Pre Treatment of sheet steel: Seven tank process as per IS 6004.
- e) Enclosure protection : IP 55 as per IS 13947
- f) 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.
- g) 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.
- h) Cable Lug: Annealed tinned solder less crimping type copper lugs shall be provided for all the terminals on both sides. Lug type shall be Dowell's pin type (insulated) or equivalent type of BHEL approved make suitable for 0.5 sq mm stranded copper wire.
- i) Cable Gland: Nickel chromium plated Brass Double Compression type cable glands fixed on the gland plate, with dummy plugs. The cable gland shall be suitable for 8 pair x 0.5 sq. mm PVC un-armoured cable. Cable Entry shall be bottom only.
- j) Earthing terminals: Two sets of Earthing bolts & nuts with lug shall be provided. Each shall be located at opposite points on outside of the SVEB with earth symbol.
- k) Mounting fasteners :4 sets of chromium plated bolts, nuts and spring washers for mounting the SVEB shall be supplied
- l) Seams: All seams are to be continuously welded. There shall be no holes or sockets on top and sides.
- m) Rolled lip: 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.
- n) Name Plate: Two numbers of lamicoid Name plate in white colour with the following inscription in black letters shall be fixed to the mounting bracket on top of the SVEB with plated screws.
- o) Canopy: Canopy for protection for all weather condition/direct sunlight/ direct rain shall be fixed on the top of the SVEB with minimum four sets of SS/Brass bolts ,nuts & spring washers.
- p) The SVEB shall be painted with two coats of epoxy based Zinc Chromium primer and finally finished with two coats of epoxy paint with Light grey shade 631 as per IS 5 & paint thickness 50 microns.

18.4.2 TERMINAL BLOCK

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.

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Terminal block type & arrangement : ELMEX CST 2.5 or equivalent type of BHEL approved make mounted on DIN rail, Melamine type having voltage grade 650 V (Minimum)

18.4.3 SOLENOID VALVE:

- a) Quantity in each SVEB : As per Enquiry
- b) Type : Multi-way Solenoid valve suitable for double acting actuator. (as standardised)
- c) Body : SS316/Die Cast Aluminium
- d) Plunger/trim : SS316
- e) Pressure range : 5 to 8 Kg/sq. cm
- f) Duty : Continuous
- g) Coil Voltage : 24 V DC
- h) Class of insulation : " F "
- i) Manual override for SOV : Required
- j) Shut off class : tight shut off
- k) Make : ASCO/AVCON/ROTEX/NORGREN/ Reputed
- l) Low power type Solenoid Valves shall be considered.

18.4.5 MAKE OF COMPONENTS

- a) Terminal block: ELMEX / CONNECTWELL / TOSHA CONTROLS & SWITCHGEAR / WAGO
- b) Crimping type lug: DOWELLS / JAINSON / LOTUS
- c) Cable glands: COMET / BRACCO / ANUP ENGG./ QUALITY PRECISION/ SUNIL & Co. / SIEMENS / CONTROLS & SWITCHGEAR / SCHNEIDER
- d) Solenoid valve : ASCO/AVCON/ROTEX/NORGREN

Make of sub-components shall be subject to BHEL approval.

19. SPECIFICATION FOR INSTRUMENT VALVES, FITTINGS AND MANIFOLDS

19.1. PROCESS CONNECTION AND PIPING

19.1.1. General Requirements

This section covers the material requirement for instrument connection to process, instrument process, piping, tubing, supports, transmitter racks and main accessories to be furnished under this specification and the requirements of installation and routing. Impulse lines, fittings and other accessories required for the erection of complete Instrumentation and Control System supplied under various packages of this specification shall be supplied on "as required" basis. Bidder shall offer all necessary items for this section based on his experience on similar plants, plant layout diagrams, installation drawings and other applicable sections of this specification. Based on the good engineering practices Bidder shall furnish installation drawings during the engineering of the system for Owner's review and approval. The installation of the drawings shall be suitable for his installation of his range of instrumentation.

The Bidder shall furnish and test all required erection hardware, which is necessary for proper installation and interconnection of the equipment/systems furnished by

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the Bidder and their integration with main equipment/systems as per the enclosed installation drawings and other applicable clause. The Bidder shall furnish all hardware and accessories to ensure that the equipment/systems furnished form a complete and operational system meeting the intent and requirement of this specification.

All materials, furnished shall conform to the latest editions of America National Standard Code for Pressure piping, Power piping, ANSI B311.1, ANSI B16.11, ASME Boiler and Pressure Vessel Codes, IBR and other applicable ASME, ANSI and Indian Standards. Schedule numbers, sizes and dimensions of all carbon steel, stainless steel and alloy seamless steel pipe shall confirm to ANSI B.36.10 and of stainless steel pipe shall confirm to ANSI B 36.19 unless otherwise specified.

All materials supplied under this section shall be suitable for intended service; process operating conditions and type of instruments used and shall fully conform to the requirements of this specification.

The Bidder is responsible for the performance of the equipment furnished on system basis any shortfall in erection material observed during erection stage shall be compensated by the Bidder at no extra cost.

For Low Pressure application (Sea/saline water), MOC of impulse tubing & fittings shall be CPVC (3/8") Sch80, Industrial grade. For whichever instruments, manifolds are applicable, the MOC of impulse tubes, fittings (from manifold to instrument) and manifold shall be of Super Duplex/ Duplex SS MOC. For High pressure application (SWRO feed & brine line), MOC of Impulse tubing & fittings shall be Super Duplex/ Duplex SS (1/2"), MOC of fittings & manifold shall be Super Duplex/ Duplex SS(1/2"). MOC/Equipment for installation shall be as mentioned above which is subject to customer approval.

19.1.2. GUIDLINE FOR INSTALLATION AND ROUTING OF INSTRUMENT PIPING

19.1.2.1. General Requirements

The following general erection guidelines have been enumerated here to enable the Bidder to estimate the requirement of instrument piping in plant:-

- i) All instrument piping shall be in accordance with good engineering practice. It shall be finalized during engineering stage. Instrument piping shall be complete with fittings, valves and other required accessories.
- ii) Instrument piping shall not be routed:-
 - a) Across equipment removal areas
 - b) Below mono-rails and cranes
 - c) Above or below removable gratings
 - d) Above or below cable trays.
- iii) Primary Impulse Piping System:
 - a) The primary impulse piping system shall include the instrument piping and all required accessories from process tap off point (root valves

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onwards) up to the respective instruments. From the same source, Tee off for instruments are not allowed. Separate tapping shall be provided for each instrument. The Bidder shall provide the necessary fittings and accessories along with impulse pipes for completeness and arrangements as per the finalized Instrument Installation Diagrams. Special accessories such as reservoirs and other devices shall be installed as required for flow primary element connection as required by the design of instruments, in accordance with the instructions of the instrument manufacturer.

- b) The Bidder shall prepare impulse pipe routing drawings.
- c) Impulse piping shall include a blow-down line and shut-off valve adequate for the duty requirements and for withstanding continuous design pressure and temperature of process medium. For process pressure above 40 Kg/Cm²g, double valves shall be used before connecting to the blow-down header (This arrangement shall be provided for installation for the new transmitter if the existing transmitter has the same arrangement.)
- d) To assure a constant static head the connections from low pressure steam and low pressure liquid filled lines should preferably slope downward continuously towards the instrument as the instrument is mounted below the source point. If downward slope is not feasible or the instrument is mounted above the source point, the line should slope upward continuously and a “pigtail” installed at the instrument to assure a water seal for temperature protection. Upward sloping liquid lines should be used only if the process pressure is sufficient to assure a head of liquid at the instrument. Horizontal runs should have a slope of not less than 40 mm per meter and must be adequately supported to maintain a constant slope.
- e) Primary process piping for liquid flow measurement systems should preferably slope downward from the primary element connections to the instrument. Primary piping for air flow measurement systems should preferably slope upward from the primary element connections to the instrument. If these requirements cannot be met, special venting or drain provisions will be required. Horizontal runs must have a slope of not less than 40 millimeters per meter and must be adequately supported to maintain a constant slope.
- f) Primary process piping from the field which enters the instrument enclosure from the bottom shall extend into the enclosure approximately 150 millimeters and be equipped with a socket weld to flare less tubing coupling of stainless steel. This coupling shall be used to connect the field primary process line to the enclosure process line. The field primary process line shall be anchored to the enclosure angle with U-bolts. Holes for supporting U-bolts shall be field or drilled.
- g) All impulse piping shall be supported rigidly at an interval not exceeding 1.5 meters so as to prevent excessive sag in piping. Process piping shall not be used for supporting impulse piping.

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- h) Impulse lines subject to severe sonic pulsations shall be of sufficient length and of suitable configuration to scatter harmful sonic wave energy before it reaches the instrument.
- i) Impulse piping shall be installed to permit thermal expansion without placing excessive stress on the piping and without affecting the gradient of slope. Long continuous straight runs of piping shall always be avoided. If required, expansion loops shall be provided at least every 2.5 meters to break the continuity.
- j) All welded and screwed fittings shall conform to ANSI B16.11. Threads of piping components shall be taper pipe thread in accordance with ANSI B2.1. All threads shall be clean machine cut with all burrs and chips removed. Lubricants shall be of dry file type. Any one of the following compounds may be used as a pipe thread sealer. Bidder shall supply adequate amount of his preferred sealer for erection purpose.
 - a) Permatex
 - b) Molycote
 - c) Neolube
 (Teflon tape shall not be used as a pipe thread sealer).

19.1.2.2. Impulse Piping System

Impulse piping system consists of primary impulse pipes/tubes, valves, fittings, valve manifolds and other accessories between the source connection point (source shut-off valve onwards) and all instruments/devices. Impulse pipe span for supporting clamp shall be 1.5 mtr. This will also include all piping and valves etc. required for instrument drain and vent connections. The Bidder shall furnish and test all items required for completeness of this specification.

19.1.2.3. AIR SUPPLY PIPING

The piping for air supply shall be as specified below (However the Bidder shall supply the materials as required basis to complete the system in all respect)

i) Individual Supply Lines and Control Signal Lines:-

Air lines shall be ¼ inch size, connected by SS316/brass flare less tubing fittings. SS316/ PVC coated copper tubing shall be light drawn tampered tubing conforming to ATM B75 except copper tubing in tubing cables shall be annealed soft temper tubing conforming to ASTM B68 or B75. Fittings on the branch line to facilitate connections to the individual supply line shall be cast brass screwed type.

ii) Flexible Hoses:-

Flexible hoses shall be ¼ inch SS flexible hose pipe and with Buna-N liner steel wire braid reinforcement complete with ¼ inch brass/SS316 fittings and shall have swivel male pipe threads. Each hose shall be done meter in length.

iii) Pipe Material Specification:-

The piping material shall be carbon steel hot-dipped galvanized inside and outside as per IS-1239 or the equivalent of these standard heavy quality with screwed ends. The piping threads shall be as per ASA B.2.1.

iv) Isolating Valves:-

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Gate valves as per ASTM B62 inside screw rising stem screwed female ends as per ASA B2.1 valve bonnet shall be union type and trim shall be stainless steel body rating 150 pounds ASA. Valves sizes shall be ½ inch to 2 inch.

v) Fittings:-

Forged cast steel A234 Gr. WPM galvanized inside and outside; screwed as per ASA B2.1 dimensions as per ASA B16.11, rating 2000 pounds, elbows and soft seats. The size of the fittings shall be ½ inch through 2 inch.

vi) Air Filter Regulator Set:-

An instrument Air Filter Regulator Set with mounting assemblies shall be provided for each pneumatic device requiring air supply.

vii) Instrument Air Piping System:-

- a) Instrument Air shall be made available by the bidder at 6 Kg/cm² pressure.
- b) Air supply piping shall be installed at site always with a slope of over 1/100 to prevent accumulation of condensed water within the pipe.
- c) All joints in the instrument air sub-header shall be of screwed type.
- d) Instrument air line shall be separate for each individual instrument, equipment & drive with own isolation valve and other required hardware. Tee off of instrument line for two or more same/similar services instrument, equipment & drive are not acceptable.

viii) Signal / Control Air Tubing System:-

Necessary tubes with fittings and accessories for output signal from pneumatic instruments mounted in the field and control signals to final control elements shall be covered under this tubing system.

19.2. SPECIFICATION FOR ERECTION HARDWARE

The erection hardware shall meet the following specifications:-

19.2.1. Impulse Piping

- i) High pressure and high temperature services (Medium: Steam & Water and furnace region) Seamless Alloy Steel piping to ASTM A335 GR.P91/22 (schedule XXS/160 for high pressure & high temperature)
- ii) Low pressure and low temperature services (Medium: Steam & Water) Seamless carbon steel piping to STM A106, Gr.C
- iii) Low pressure and low temperature services (Air, Flue gas) ERW carbon steel piping to IS 1239:1973 Heavy class System)
- iv) Steam and water analysis system Seamless stainless steel piping to ASTM A312 GR. TP-321
- v) Seamless copper tubing ASTM B-75

19.2.2. Fittings Double compression type

- i) Material for socket weld fittings ASTM A105 ASTM A182, Gr. F22 6000/3000 lbs
- ii) Dimensions of fittings ANSI B16.11
- iii) Fittings for steam and water analysis. Gr. F-321

19.2.3. Valves

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- i) 3 – way valves : SS body/forged CS body stellited internals and SW ends as per requirement for 2500 lb/800 lb ASA ratings.
- ii) 5- valve manifolds: FAS body/FCS body DUPLEX SS/316SS stellited internals with NPT(F) SCRD ends for 3000/2500 lb/1500 lb/800 lb ASA ratings.
Construction – Single block (Bar stock)
- iii) 3-valve manifolds FAS body/FCS body DUPLEX SS/316SS stellited internals with NPT(F) SCRD ends for 3000/2500 lb/1500 lb/800 lb ASA ratings.
Construction – Single block (Bar stock)
- iv) 2-valve manifolds FCS body, DUPLEX SS/ 316SS stellited internals, NPT(F) SCRD ends. Construction – Single block (Bar stock)
- v) Isolation and drain valves Globe valves with FAS body/FCS body, DUPLEX SS/ 316SS stellited internals SW ends for 3000/2500 lb/1500 lb/800 lb ASA ratings.

19.2.4. Racks and Associated Equipment ANSI C83.9-1972

19.2.5. Code for pressure piping, welding and Hydrostatic testing ANSI B-31.1

19.2.6. Flexible conduits with fittings Lead coated, paper insulated, heat resistant flexible metallic conduits with necessary fittings.

19.2.7. 3 Valve manifold shall be used, wherever Diff Pressure transmitter/switch have been used for pressure measurement.

19.2.8. 5 Valve manifold shall be used for Diff. Pressure & Flow measurement Transmitters/Switches.

19.2.9. In addition to above, table at the end of this section shall also be followed for selection of specific erection hard ware as per process requirements.

19.3. TRANSMITTER & SWITCHES ENCLOSURES

In general, transmitters & switches installed at outdoor location and in areas where they are subjected to splashing oil, water, steam etc., shall be mounted in closed type transmitter rack. For other areas (indoor), open type racks may be used for installation of transmitters and process switches. However the actual requirement shall be finalized during detailed Engineering considering following:-

- i) Transmitter/Switches enclosures shall be free standing, enclosed type offering protection against dust, moisture and vermin. Enclosures shall be suitable for outdoor installations, in thermal power plants.
- ii) The enclosures shall comprise of Galvanized Sheet mounting plate internally. Also external-mounting brackets in Polyamide or Stainless Steel shall be available. Alternatively transmitter enclosures can be glass Fiber Reinforced Polyester (GRP) compression moulded and shall be weather proof.
- iii) Instrument piping inside the enclosure shall conform to the specification and in line with typical installation/Hook-up drawings enclosed with the specification.
- iv) Blow down header shall be provided inside the enclosure as called for.
- v) Bulk head connection shall be provided to receive and terminate the impulse pipes from root valves.
- vi) Instrument tubing, fittings and isolation, drain valves shall be to ANSI code for pressure piping. Piping/tubing shall be subject to hydrostatic tests at 1.5 times maximum system pressure.
- vii) Support angles shall be provided for valve manifolds, wiring trays etc. Enclosures shall be complete with necessary bulk head fittings, junction boxes, drain header and other accessories as needed on the basis of approved hook up drawings.

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- viii) Sufficient spacing among adjacent transmitters shall be maintained to offer easy accessibility and operational convenience. The enclosure shall be designed with sizes to suit the grouping and to completely include all the hardware for hooking up the transmitters to the process on the basis of approved installation diagrams. A maximum of five (5) transmitters are envisaged to be grouped in one enclosure.
- x) A minimum of twenty (20) percent spare terminals shall be provided. Only one wire per terminal shall be used on the outgoing side of these blocks (for cable panel). Any common connections required shall be provided on the panel side of the block. All incoming power terminals are to be clearly identified in a manner distinctly different from all other terminals and grouped in a logical pattern.

19.4. LOCAL INSTRUMENTS, LOCAL BOARDS AND TAPPING POINTS

- i) All local gauges as well as sensors, Transmitters and switches any other instruments for parameters like pressure, temperature, level, flow etc for safe and efficient operation of equipment under the scope of specification, shall be provided by bidder as approved by Owner. Such equipment shall be listed by the Bidder detailing the items with the respective functions in service. All field mounted instruments shall be mounted in such a way as not to be affected by vibration & environmental conditions. Racks to mount these instruments shall be furnished by bidder complete with requisite erection hardware, tubings. Groupings of instruments, actual number of racks for instruments and its construction shall be to Owners approval.
- ii) Transmitters & Switches provided shall be mounted in transmitter/Switches enclosures to owner's approval.
- iii) All erection hardware required for complete installation/ implementation of entire instrumentation specified is included in bidders scope. Any change in size, type, rating or in quantity deemed necessary during engineering shall be supplied within package price with no additional financial implication to owner.
- iv) Bidders scope includes providing counter flanges on pipe lines/ vessels to suit owner arranged flanged devices. Counter flanges shall be complete with gaskets, nuts, bolts and other requisite accessories for proper installation.
- v) Separate and independent tapping on equipment/associated piping shall be provided to suit the philosophy of redundant primary sensors. Separate sensors for control and monitoring etc are as decided by Owner. This shall include application such as first stage pressure. Wherever the process value being measured needs to be compensated for temp, pressure variations, the tapping points for such compensating elements shall be provided in requisite number along with the tapping for the process value.
- vi) Wherever transmitters & switches are provided, in addition Local gauges shall also be provided by bidder for local field monitoring as per P&ID.
- vii) Local instruments and remote sensors & transmitters to be furnished with the equipment shall generally be as indicated herein and as per redundancy criteria indicated elsewhere but not be limited to the following: -

1. Pressure Measurement

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i. Pressure Gauge for:

Pressure gauges at inlets and outlets of pumps.

Pressure gauge in the field at the main location of instrument/service air header.

ii. Pressure Switches

Pressure switches at pumps for alarm (high & low) and interlock purpose.

Pressure switches (low & high) for individual pumps/blowers suction/discharge and discharge header – alarms, interlocks and protection

At the main location of instrument air header the pressure low switches shall be provided for alarms in DDCMIS

Pressure switches/any other process switch etc. for OLCS / Alarms / Interlocks / Protection.

Pressure switches at inlet, outlet of individual pumps and discharge header of pumps for protection and auto start / stop & alarms.

iii. Differential Pressure Transmitters, Diff Pressure Switches & Diff. Pressure Gauges

Pressure across strainers and filters.

iv. Pressure Transmitters

a) For all services as mentioned for Pressure gauges & Pressure Switches.

b) Pressure Transmitters at pumps for alarm (high & low) and interlock purpose.

d) Pressure Transmitters as on required basis for monitoring, interlocks & controls as per redundancy criteria and approved by owner.

Above are the minimum requirements, actual quantities shall be as decided during detailed engineering as per redundancy criteria and approved by owner.

2. Temperature Measurements:-

The Bidder shall furnish all temperature sensing elements to be installed in their piping. The scope of supply shall include, but not limited to the following: -

- i. Duplex RTDs for all bearing no. duplex or 12 no. simplex Embedded temperature detectors for various motor stator windings and duplex RTDs for Motor/Pump bearing temp.
- ii. Adequate number of temperature Elements shall be furnished to provide initiating contacts for temperature interlocking and trip circuits. The temperature elements shall be provided, but not limited to the following: -
- iii. **Temperature gauges.**
quantities as per BOQ,PID & specification

3. Level Measurement

- i. Level switches The separate switches for high, very high and low levels shall be provided as per interlocks and protection requirements.
 1. External cage mounted magnetic level switches/ displacer type shall be employed for low pressure & low temp. services.
 2. However conductivity type level switches shall be provided for high pressure & high temp services
- ii. Level Transmitters (Type as per Owner approval) for open sump/tank.
- iii. Level switches for OLCS / Alarms / Interlocks / Protection. Level switches for sump/tank level high/normal/ low/very low interlocks.

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4. Flow Measurements:-

Quantities and type of instrument as per BOQ,PID & specification.

19.5. Process Connections

The type of instrument source connection shall depend upon the process parameters and the tapping size. The source connection drawings shall be finalised during the engineering stage. Size of tapping point stub, number and size of root valves for different types of measurements are as follows:

Sl. No.	Quantity of root valves	Size of stub and root valve	Service Condition
Pressure and Differential Pressure Measurement			
(i)	2	25NB	> 40 bar(g) OR 425 ⁰ C
(ii)	1	15NB	< 40 bar(g) AND 425 ⁰ C.
Level Measurement			
(a)		Level Gauge & Switch	
(i)	2	25NB	> 40 bar(g) OR 425 ⁰ C
(ii)	1	25NB	< 40 bar(g) AND 425 ⁰ C
(b)		Level transmitter (displacement type)	
(i)	2	40NB	>40 bar(g) OR 425 ⁰ C
(ii)	1	40NB	<40 bar(g) AND 425 ⁰ C
(c)		Stand pipe for level measuring instrument	
(i)	2	80 NB	>40 bar(g) OR 425 ⁰ C
(ii)	1	80 NB	< 40 bar(g) AND 425 ⁰ C
Flow Measurement			
(i)	2	25NB	> 40bar(g) OR 425 ⁰ C
(ii)	1	25NB	< 40 bar(g) AND 425 ⁰ C
Sampling system measurement (Steam and Water Service)			
(i)	2	25 NB	>40 bar(g) OR 425 ⁰ C
(ii)	1	25 NB	< 40 bar(g) AND 425 ⁰ C

Reference Drawings:

Typical hook-up drawings: 3-WT-310-00580-89, 3-WT-310-00581, 3-WT-310-00082, 3-WT-310-00583, 3-WT-310-00584, 3-WT-310-00085, 3-WT-310-00086, 3-WT-310-00087, 3-WT-310-00088, 3-WT-310-00089

Shall be finalized during detailed engineering.

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20. SITE TESTING AND CALIBRATION

All impulse lines shall be tested hydrostatically at 1.5 times the maximum operating pressure. Ensure that instrument and vessel/piping is isolated during this test.

In case of special instruments/items where hydro testing is not permitted due to service conditions, the impulse lines testing shall be carried out by using air or nitrogen.

All external cage type level instruments shall be tested upto 1.5 times operating pressure by using nitrogen only.

After pressure testing, all these impulse lines shall be drained and dried with dry air to remove any traces of moisture, oil and dust.

Instrument air lines shall be duly tested for any leak after pressurising and isolating the main root valve by soap solution. After isolation, the rate of fall in pressure shall be less than 1 kPa for every 4.4 meter (1 psi for each 100 feet) of copper tubing for a test period of 2 minutes.

Pneumatic signal tubes shall be flushed and tested with instrument air for any leak at a pressure of 1.5 kg/cm²g. After pressurising the line, the source of pressure is cut off and rate of fall in pressure shall be less than 1 kPa for every 4.4 meter (1 psi for each 100 feet) of tubing for a period of 2 minutes.

Bubble tight shut-off control valves and shut down valves shall be checked for seat leak test and gland leak test.

Solenoid valve shall be checked functionally for its operation.

Safety valves and relief valves shall be set/tested by using dry air/nitrogen. Leakage if any shall be removed by proper lapping of seat and disc.

20.1. Calibration

All instruments shall be calibrated strictly as per manufacturer's instructions prior to installation. The scope of calibration includes all field and control room instruments of all types namely, pneumatic, electronic, electrical etc.

Oil free instruments air compressor shall be used for calibration purposes.

Conversion from one unit to another for the purpose of calibration is not allowed.

The procedures for calibration of different items are as outlined below. However, the detailed procedure shall be submitted to Engineer-in-charge for approval before proceeding with calibration.

All types of transmitters, including SMART/FIELDBUS type, shall be calibrated to the ranges specified in the respective instrument data/specification sheets using suitable test equipments/kits including the verification of the configuration parameters.

All pressure and differential pressure transmitters shall be calibrated to the ranges as per Instrument data/specification sheets and instructions of Engineer-in-charge.

All thermocouple receiver instruments shall be calibrated by generating millivolt signals suitable for span and the type of thermocouple specified.

Receiver instruments programmed shall be calibrated and aligned using test hook-up as per instructions from manufacturer/engineer-in-charge.

All indicating type pressure, differential pressure and temperature switches shall be calibrated for 0%, 25%, 50%, and 100% of range. These shall be set finally at the required values indicated on the data sheet.

Filled type temperature instruments/temperature gauges shall be calibrated for 0%, 25%, 50%, 75% and 100% of the range using standard thermo-oil.

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Pressure transmitters shall be calibrated at 0%, 25%, 50%, 75% and 100% and vice versa of range using dead weight tester/hydraulic pumps with master gauges/pressure calibrators.

DP transmitters shall be calibrated at 0%, 25%, 50%, 75% and 100% and vice versa of range using water column monometers, standard gauges or squeeze bulb type of flow calibrators.

Rotameter transmitters shall be calibrated by moving pointer 0%, 25%, 50%, 75%, 100% and vice versa of the range and monitoring the output at the respective flow range.

The external displacer type of level instruments shall be dry calibrated as per manufacturer's instructions or wet calibrated by filling the displacer chamber with water for level 0%, 25%, 50%, 75% and 100% and draining the water at 100%, 75%, 50%, 25% and 0% of the ranges after applying suitable specific gravity corrections of the process fluid as per data sheets.

The internal displacer/float type level instruments shall be dry calibrated as per manufacturer's instruction or using calibration chamber fabricated out of steel pipes and filling the same with water after applying specific gravity corrections of process fluid as per data sheets.

The level switches (external cage type) shall be set by filling the cage with water to the desired alarm/trip level. While setting the switches, it shall be ensured that the micro switches do not reset for full rated travel of the float.

Tank level indicators shall be calibrated by manually lifting the float at 0%, 25%, 50%, 75% and 100% and vice versa of the ranges.

Control valves and positioners of all types (Pneumatic / SMART / Fieldbus) shall be checked for hysteresis and linearity and shall be calibrated for rated strokes. Prior to calibration, the valves shall be cleaned externally. The stem is then lubricated if required, and stroked few times to extreme positions of plug to ensure that movement is free from friction. The valve shall then be calibrated for rated stroke and linearity also. Subsequently the valves shall be checked for hysteresis to the accuracy of 1% full scale with Fieldbus / SMART / Pneumatic positioner and 5% full scale without positioners.

All calibration readings shall be recorded in the enclosed format and submitted to engineer-in-charge for approval. Where significant deviations from specifications are obtained, the matter shall be brought to the immediate notice of the Engineer-in-charge for corrective action.

All the instruments are to be calibrated using the test equipments and kits approved by NPL/IDEMI/ERTL authorities or by any laboratory accredited by NABL having valid calibration report at the time of calibration.

After performing calibration of all instruments, entire loop shall be checked for proper operation.

All special instruments like analyzer shall be checked and calibrated as per manufacturer's instructions. Prior to testing, all analyzer sample lines shall be thoroughly cleaned by carbon tetra chloride or any other cleaning liquid. After cleaning, these lines shall be thoroughly purged with dry nitrogen.

The entire shutdown scheme shall be simulated from the process trip switches and the scheme shall be tested for its proper operation prior to start up of the unit.

If no instrument air is available Bidder shall provide necessary nitrogen cylinders to carry out the above activity.

Testing of Systems

All the system functions shall be checked thoroughly for proper functioning. These shall include but not limited to the following tests:

- Visual and mechanical.
- Complete system configuration loading.
- Demonstration of all system functions.
- Checking of all systems displays.

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- e) Checking of correct functioning of all keyboards.
- f) Demonstration of all system diagnostics.
- g) Checking of proper functioning of all printers, hardcopy unit, and printing of all reports.
- h) Checking of all disc drives.
- i) Complete checking of logic system, loading of user's program and checkout of results.
- j) Checking of correct change-over of the back-up/redundant units in case of failure of main units.

The input signals shall be simulated by disconnecting the field wires for all inputs. Wherever control room mounted Transmitters/Converters/Receiver switches are used, the functioning of same shall also be checked.

Bidder shall provide assistance for the above along with necessary loop checking in coordination with DCS supplier.

COMMISSIONING

This activity shall be carried out in a systematic manner so as to avoid any accident to plant and operating personnel.

During the plant start up all the instruments calibration, controller alignment, trip point settings shall be trimmed so as to meet the operation requirements.

Prior to guarantee run of any unit, the vital instruments as required by Bidder have to be recalibrated and the results recorded.

As built drawings shall be prepared after installation and commissioning is over.

TRAINING

Unless specified otherwise the following shall be provided by Bidder for system training for owner.

Bidder shall arrange training for Owner's personnel. Different type of courses shall be offered for operation/ process engineers and operators, instrument maintenance engineers and technician. Bidder shall indicate a detailed proposal for training in the offer. Travel and living expenses of the owner's personnel shall be borne by the Owner. Apart from the hardware and software maintenance training, Bidder shall also offer operation training basically meant for operating personnel. The various facilities available in the system for operation, actions required during emergencies and identifying the various diagnostic messages shall be main contents of operation training.

Hardware and Software maintenance training	- At system Bidder's works.
Operation Training	- At system Bidder's works
Site Training	- Operation and maintenance

21. QUALITY ASSURANCE AND TESTING AND GUARANTEES

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21.1. GENERAL REQUIREMENT

- 21.1.1. All equipment furnished under this specification shall be subject to test by authorized quality assurance personnel of the Bidder, representatives of the Owner during manufacture, erection and on completion. Bidder's quality assurance personnel for these shop and site tests shall be identified in advance and shall be acceptable to the Owner. The approval of the Owner or passing of such inspection of tests will not, however, prejudice the right of the owner to reject the equipment if it does not comply with the specifications when erected or fails to give complete satisfaction in service.
- 21.1.2. The Bidder shall furnish details of shop and site tests proposed to be conducted by him at various stages to meet the specification requirements for each type of instrument/system along with his proposal. Bidder shall also furnish details of his proposed shop and site quality assurance organization for this contract
- 21.1.3. Bidder shall prepare a detailed shop and site 'Quality Assurance Programme' to meet the requirements of these specifications for Owner's approval. This document shall also contain the formats for reports and maintenance of test records specification of test equipment to be used for site tests.
- 21.1.4. All equipment and systems furnished under this specification shall be subjected to shop & site tests in accordance with the Quality Assurance Program approved by the Owner and shall be adequate to ensure full compliance with these specification, all applicable codes & standards and detailed engineering drawings and documents approved by the Owner.
- 21.1.5. The Bidder shall provide all required test equipment and simulation devices for performing all shop and site tests. All tests equipment shall be of reputed make, required accuracy class and shall be recently calibrated. The record of calibration of test equipment shall be made available to the Owner on demand.
- 21.1.6. The cost of all tests as per the requirements of this specification and approved quality assurance programme shall be included in Bidder's lump sum price for this package and no extra price shall be payable by the Owner for conducting any test as per the intent and requirements of this specification.
- 21.1.7. All approval/Inspection are to be carried out by the Owner only.

21.2. SHOP TESTS

21.2.1. General Requirement

- 21.2.1.1. Shop tests shall include all tests to be carried out at Bidder's works at of this sub-bidder and at works where raw materials used for manufacture of equipment is produced.
- 21.2.1.2. Individual components, instruments and devices furnished in accordance with specification sheets, and I&C device list enclosed with these specifications shall be shop tested by manufacturer prior to shipment. The manufacturer shall conduct these tests for certifying compliance with published specifications for the equipment and provide test results to the Owner in writing. These tests and test certificates shall be in accordance with the agreed 'QA' programme for major systems/equipments. However, manufacturer's standard methods shall be followed if details of tests for any equipment are not covered under this agreed 'QA Programme'.
- 21.2.1.3. Whenever tested quality material is specified and wherever called upon by Indian Boilers Regulations or by the design code, the test pieces are to be prepared and tested to Owner's satisfaction.

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21.2.1.4. In the event of Owner being furnished with certified particulars of tests, which have been carried out by the suppliers of material, the Owner may, at his discretion, dispense with these tests.

21.2.2. Material Tests

21.2.2.1. Whenever tested quality material specified and whenever called upon by Indian Boilers Regulations or by design code, the test pieces, are to be prepared and tested to Owner's satisfaction.

21.2.2.2. In the event of Owner being furnished with certified particulars of tests, which have been carried out by the suppliers of material, the Owner may, at his discretion, dispense with these tests.

21.2.3. Test at Manufacturer's Works

21.2.3.1. Works tests are to include electrical, mechanical performance and hydraulic tests in accordance with relevant IS, IBR or any other approved standard or any other tests called for by the Owner under these specifications to ensure that the equipment being supplied fulfills the requirements of these specifications. For equipments not covered by any IS or other approved standards, the tests to be carried out shall be in accordance with Bidders' quality assurance programme approved by the Owner.

21.2.3.2. Control systems, monitoring systems ,control panels instrument enclosures ,and power supply systems shall be shop tested according to unique requirements specified in the applicable section of these specifications for each item and quality assurance program approved by the owner.

21.2.3.3. All shop tests shall be performed prior to shipment and the Owner shall be given the opportunity to witness these tests. The Bidder shall notify the Owner regarding readiness for shop test at least 10 days before the scheduled date if the tests to be conducted within Indian and at least 60 days before the schedule date if the test is to be conducted abroad.

21.2.4. Factory Tests

Automatic Control and Monitoring system (DDCMIS, PLC & any other microprocessor based control system) including alarm annunciation system furnished as per this specification shall be subject to shop and site tests as per the requirements of this specification, applicable codes and Owner approved Quantity Assurance Program so as to demonstrate to the Owner that the equipment furnished by the Bidder meets the intent and requirement of this specification. These tests shall include but shall not be limited to the tests indicated in the subsequent clauses.

21.2.4.1. Surge Protection Test for Solid State Equipment

All solid state equipment shall be able to withstand the noise and surge inherent in a Power House, and shall strictly comply with SWC tests ANSI C 37.90A, 1974 for IEEE-472 (1974). Complete details of the features incorporated in electronic system to meet this requirement, the relevant test carried out, and the test certificates shall be submitted along with the proposal.

21.2.4.2. Burn-in and Elevated Temperature Test

All solid state electronic equipment shall be tested as a complete system/equipment with all devices connected for a minimum of 168 hours continuously under energized conditions prior to shipment from manufacturer's works, as per the following cycle :-

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During the first 48 hours of testing the ambient temperature shall be maintained at 50 deg.C and relative humidity at 95%. The equipment shall be interconnected with all devices, which will cause it to repeatedly perform all operations; it is supposed to perform in actual service, with load on various components being equal to those, which will be experienced in actual service. The 48 hours tests period shall be continuous but shall be divided into four 12 hours segments. The input voltage during each 12-hour segment shall be nominal voltage for 11 hours, followed by 110% of normal voltage for 30 minutes followed by 90 percent of nominal voltage for 30 minutes. The 48 hours elevated temp test shall be followed by 120 hours of burn in test as specified in the above paragraphs except that the temperature is reduced to ambient temperature prevalent at that time. Alternatively copy of type test certificate for burn-in test shall be submitted.

21.2.4.3. The Bidder shall furnish full details regarding shop tests and site tests, as per good engineering practices. The Owner shall approve all such tests and the supplier shall conduct all such tests without calling for additional price.

The tests shall cover factory tests, burn-in and elevated temperature tests, simulation and functional tests, insulation tests as applicable, the rating of the contact devices and components, surge withstand capability test, conformity of interconnection cables, testing and checking of other conditions deemed to be necessary with the system/equipment items.

21.2.4.4. All instruments and control equipment supplied against this contract shall be factory calibrated at least at five (5) points throughout the range and checked for their functional/performance requirements. The instruments shall also be calibrated at site prior to commissioning.

21.2.4.5. All panels, instruments enclosures, junction boxes, etc. shall be type tested for degree of protection and applicable in accordance with IS: 2147. 8.02.04

21.2.4.6. Type, routine and acceptance testing of all equipments, supplied under this contract, shall be in accordance with relevant NEEA/IS/IEC/ANSI/BS/ISA standards, in addition to the requirements of Owner approved Quality Plans. Six (6) copies of test reports shall be submitted to the Owner for approval prior to dispatch of respective equipment

21.2.4.7. The representative of Owner shall be given opportunity to witness the factory tests which shall be mutually finalized during the progress of the contract.

21.2.4.8. All control systems to be furnished for this project, shall be factory tested for circuit continuity and direction of response. The Components to be tested shall include all controllers, HAND/AUTO station, other system modules, alarm contactors and multi-conductor interconnecting cables. The tests shall be performed with all of the system components supplied by the Bidder connected to form a complete system with the sole exception of transmitters. The tests shall include a means of confirming the mathematical design response of the control system by simulating changes in system input. The tests shall be a qualitative functional test of each component of control system, which simulates dynamic inputs and monitors system outputs.

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21.3. CALIBRATION OF INSTRUMENTS

The Bidder shall carry out the calibration of instruments as indicated below by submitting the test procedure and quality assurance plan for the Owner's approval. Bidder shall also prepare detailed checklist/calibration sheets for each of the systems/equipment clearly indicating the step-by-step procedures to be carried out for calibration pre commissioning, loop checking, powering and commissioning.

The calibration of all instruments shall be checked and calibration records prepared for the Owner's use. If the instruments require recalibration at the time of installation, Bidder shall recalibrate the instruments and revise the calibration records and submit to the Owner.

21.4. TESTS TO BE PERFORMED FOR FIELD INSTRUMENTS

1.	Pressure Gauges
Calibration Hydro test (1.5 times max. pr.)	
2.	Pressure switches
Calibration test / Hydro test / Contact rating test / Accuracy test / Repeatability	
3.	Differential Pressure Gauges
Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.	
4.	Differential Pressure Switches
Calibration test / Hydro test / Contact rating test / Leak test / Accuracy test / Repeatability test.	
5.	Thermometers
Calibration / Material test / Accuracy test / Bore concentricity : + 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)	
6.	Temperature switch
Calibration / Material test / Accuracy test / Bore concentricity : 1.5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.) / Contact rating test.	
7.	Resistance temperature detector assembly.
Calibration / Material test / Bore concentricity test / Insulation test (< 500 MΩ at 500V DC) as per ISA, Hydro test for TW. Bore concentricity: + 5% of wall thickness, Accuracy test.	
8.	Thermocouple assembly
Calibration / Material test, Insulation test (> 500 Ω at 500 V, DC) as per ISA, Hydro static test (1.5 times max. pr.), Bore concentricity : + 5% of wall thickness.	
9.	Thermowells
Material test / Bore concentricity : + 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)	
10.	Level Guages
Hydrostatic test / Material test / Seat leakage test / Ball check test.	
11.	Level switches (Magnetic)
Material test / Contact rating test / Hydro test / Calibration test.	
12.	Flow Switch
Material test / Hydro static test (1.5 times max. pr.) / function test.	
13.	Flow glasses
Material test / Hydrostatic test (1.5 times max. pr.) / function test.	
14.	Variable area flow meters

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Calibration test / Material test / Hydrostatic test (1.5 times max. pr.)	
15.	Flow element
100% Radiography test / Hydro test / Calibration test, IBR Certificate.	
Calibration test for flow element shall be witnessed by Owner.	
16.	Control valves/Pneumatic block valve/Pressure regulating valve – Refer earlier section
17.	Position transmitters
Calibration / hysteresis and Accuracy test	
18.	Electro Pneumatic Convertors
Calibration test / Accuracy test	
19.	Solenoid valves
Hydrotest / Seat leakage test / CV test / Coil insulation test	
20.	Air filter regulators
Calibration test / Accuracy test	
21.	Junction Boxes
Test for degree of protection / Material test	
22.	Tests for terminal blocks
Test for moulding for flame resistant, Non-hygroscopic and Decarbonised / Insulation test between terminals / Insulation between terminal block and frame.	
23.	Thermocouple extension cable
Thermo-emf characteristic / Continuity test / Measurement on capacitance, inductance and loop resistance / Insulation resistance / High voltage test as per latest IS / Tensile and elongation test / Oxygen index test / Any other test applicable.	
24.	Mass flow meter
Performance test / Calibration test / Hydrostatic test.	
25.	pH/Conductivity measurement / Silica / Dissolved oxygen analysers:
Calibration test, Accuracy test	

26.	Sampling racks :
Hydro test, IBR Certificate for tubes and fittings.	
27.	S02 / Nox analyser / SPM analyser:
Calibration test, accuracy test	
28.	Interposing relay
Functional test, temperature rise test, H.V test, Insulation test	
29.	Transmitter Racks :
Hydro test, air leak test for piping / tubing and fittings. IBR certification as required for tubing / piping and fittings.	
30.	Pressure Transmitter
Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.	
31.	Differential pressure transmitter
Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.	
32.	Temperature Transmitter
Calibration test / Accuracy test / Ambient temperature error test	
33.	Pneumatic Block Valves

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a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test	
34.	Pressure Regulating Valve

a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test	
35.	Local Panels : Visual inspection, wiring & continuity check, H.V. and I.R. tests on panels, checking of bill of materials, functional tests.
36.	Wiring Termination & Accessories
Routine test: Conductor resistance test/High voltage test/Impulse dielectric test/insulation test/Humidity test/Temperature rise test on power circuits/short time current test on power circuits.	
Type test: Annealing test/Test for insulation and sheath/ Flame retardance test - a) Oxygen index, b) Flammability / Test for acid gas generation/test for water absorption/wet dielectric test	
37	Marshalling/System cabinets
Verification of degree of protection/Electrical tests as detailed under wiring Termination& accessories/Type test and routine test as per relevant Indian standards.	
Notes:	
1. Test Certificates in addition to inspection at manufacturers works shall be furnished for all the instruments for Owner's review.	
2. Above Test to be witnessed shall be finalized by Owner.	
3. In addition to above test, test as per approved QAP shall also be witnessed by owner	

21.5. TYPE TESTING

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		REV. NO: 00

The BIDDER shall furnish the Type test reports of all type tests as per relevant standards and codes. As well as other specific test indicated in the specification. A list of such test are given for various equipment in table titled, TYPE TEST REQUIREMENT FOR C&I SYSTEM and under the item special requirement for solid state requirements/systems. For the balance equipments/instruments. type test may be conducted as per manufacturer standards or if required by relevant standards.

A. Out of these test listed , the bidder /subBidder/manufacturer is required to conduct certain type test specifically for this contract (and witnessed by employer or his authorized representative). Even if the same have been conducted earlier as clearly indicated subsequently such tests.

B. For the rest, submission of type test , results, and certificates shall be acceptable provided following points

- The same have been carried out by the bidder/ subBidder on exactly the same model/rating of equipment. (For control valves this shall be same size, type & design).
- There has been no change in the components from the offered equipments and tested equipments.
- The test has been carried out as per the latest standards along with amendments as on the date of bid opening.

C. In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the bidder/sub-Bidder within the quoted price and no extra cost will be payable by the owner on this account.

As mentioned against certain items, the test certificates for some of the items shall be reviewed and approved by the main bidder or his authorized representative and balanced have to be approved by the employer.

The schedule of conduction of type test/submission of reports shall be submitted and finalized during pre-award discussion.

For the type test to be conducted, bidder shall submit detailed test procedure for approval by owner. This shall clearly specify test setup, instruments to be used, procedure, acceptance norms (wherever applicable). , recording of different parameters, intervals of recording precaution to be taken etc. for the test to be carried out.

21.5.1. TYPE TEST REQUIREMENTS FOR C&I SYSTEMS

Sl. No.	Item	Test requirement	Standard	Test to be specifically conducted	Owner's Approval required on Test Certificate
1	Electrical metering instruments	As per standards	IS 1248	No	Yes
2	Thermocouple	Degree of Protection Test	IS - 13947	No	No.
3	Junction Box	Degree of Protection Test	IS - 13947	Yes	Yes
4	RTD	As per	IEC-	No	No

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		standards	60751		
5	Electronic Transmitter	As standards per	BS 6447/IEC 60770	No	Yes
6	E/P convertor	As standards per	Manufact uring standard	No	Yes

7	Conductivity type level switch	Degree of protection test	IS 13947	No	No
8	Local gauges	Degree of protection test	IS 13947	No	No
9	Process actuated switches	Degree of protection test	IS 13947	No	No
10	Control valves	CV test	ISA 75.02	No	YES

11	Flow nozzles & Orifice plates	calibration	ASME PTC BS 1042	YES	YES
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21.6. Testing at Site [Prior to commercial operation]

All equipment shall be checked thoroughly in respect of the following:

Visual and mechanical testing

Complete system configuration loading functions; system diagnostics; system proper operation specified power supply specifications..

Loading of user's programme and checking out of results.

Repeating any or all such tests (as necessary) as performed at works

21.7. Modulating Control Loop Test Protection, Interlocking Sequence Control Loop Checking

Technical assistance for the above test shall be provided by the bidder with regard to system logic implementation.

21.8. Commissioning Tests

The Bidder shall perform commissioning tests for all their offered instrumentation and control devices, loops, sub-systems and systems. Commissioning tests for instrumentation and controls shall include but not be limited to -

- Test on devices and loops
- Functional tests on subsystems and systems
- Performance tests on systems to demonstrate that it meets all guarantees as proposed by the bidder

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- Fine tuning of control systems

21.9. Measurement System

The Bidder shall guarantee the proper functioning of all the measurement system equipment as specified in enclosed data sheets. The test of long-term stability of analog inputs calibration shall be demonstrated by the comparison of the results of the 8-hour stability test run at the field, using precision test voltage, with no calibration allowed during the test (no manual recalibration allowed for the time of the eight-hour field stability test. The bidder will have access to the records at all times and the test will be conducted in a manner as to satisfy the bidder that the specified operating conditions have been maintained. A complete copy of the test data will be furnished to the Bidder. In case of failure to pass the test, the bidder shall change or replace the equipment furnished so that the test can be performed successfully.

22. LIST OF MANDATORY SPARES

22.1. 10% of the number of indicators and meters offered from each model for the project or a minimum of one number per model, whichever is more. These instruments shall be supplied with three sets of blank scales.

22.2. For skid mounted instruments (if any) - 10% of total number of instruments for each model and type for the project or a minimum of one number for each model and type, whichever is more

22.3. Temperature Elements and Thermowells

1. 10% spare thermocouple/RTD elements, suitable for replacement for each type and length of element furnished with thermocouple/RTD assemblies, or a minimum of one number of each type & length, whichever is more.

2. 10% thermowells for each type of temperature sensors or a minimum of one for each type, whichever is more.

22.4. Temperature Transmitters and Electronic Transmitters (For Pressure, DP, Temp, Flow, Level), Temperature, Pressure, Flow & Level Switch, safety switches, Gauges, meters, Transducer or any other instrument etc.

10% of total number of instruments/transducers offered for each model and type for the project or a minimum of one number, whichever is more.

22.5. Mandatory Spares for Control valves, Actuators and Accessories

(A) Following spares shall be furnished for control valves, Power Cylinder, Control Dampers as applicable.

- One set of spare control valve stem packing for each control valve.
- Two moulded rubber diaphragms for each control valve.
- One sets of each of O-rings and rubber gaskets for each control valve.
- 100 percent qty. of lubricants for gaskets for each control valve on one year consumption basis.
- 2 sets of limit switches and 1 set of valve positioner for each control valve.
- 20 percent of position transmitter (4-20mA) for total qty. of control valve.

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- g) One (1) set of valve trims (such as plug, stem, seat ring / cage, guide bushing, stem lock pin, packing retaining ring, etc) for each control valve.
- h) One completes actuator of each type or min 10% for each type and size whichever is more.
- i) 20 percent of Solenoid valves or min 2 no. of each type for total qty. of control valves.
- j) 20% of I to P converters, Pressure regulators.

22.6. Mandatory spares not covered above

Bidder to supply 10% or 1 no. (whichever is more) of each type of sensor/instrument, analysers /special instruments/Electronic card, instrumentation/mechanical fittings etc for any other electronic system.

1	MAINTENANCE SPARES	
a	Pr. Gauge	Two (2) Nos. for each Range / Type
b	Flow Indicator (Bypass / on line type)	Two (2) Nos. for each size
c	Float	
d	Meter tube	One (1) No. for each size
e	Gaskets	Three (3) Nos.
2	LEVEL GAUGE	
	Glass tube	Five (5) Nos. for each size
	Offset valve	Two (2) Nos. for each size
3	LEVEL SWITCH (SIDE MOUNTED)	
	Float & Rod	One (1) No. for each size
	Switch assembly	One (1) No. for each size
	Magnet	One (1) No. for each size
4	CONDUCTIVITY INSTRUMENT	
	Complete meter	One (1) No. for each size.
	Neon Lamp	Two (2) Nos. for each size.
	Power Supply Card	One (1) No. for each size.
	Controller PCB	One (1) No. for each size
	Transformer	One (1) No. for each size
	Relay	Two (2) Nos. for each size.
	Meter Movement	One (1) No. for each size

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	Cell	One (1) No. for each size
5	PH INSTRUMENT	
	Complete meter with cell & accessories	One (1) No. for each size
	Neon lamp	Eight (8) Nos. for each size.
	Power supply card	One (1) No. for each size
	Amplifier PCB	One (1) No. for each size
	Controller PCB	One (1) No. for each size
	Transformer	One (1) No. for each size
	Relay	One (1) No. for each size
	Meter movement	One (1) No. for each size
	Electrodes Assembly	One (1) No. for each size
6	Motors – Bearings	One (1) Set each for drive end and Non drive end.

NOTES:

1. The word 'TYPE' means the Make, Model no., Type, Range, Size/ Length, Rating, Material, accessories as applicable.
2. Wherever % age is identified, Bidder shall supply next higher rounded figure.
3. The terminology used under 'Part Description' is the commonly used name of the part and may vary from manufacturer to manufacturer.
4. Commissioning spares are part of Bidder scope of supply. Mandatory spares as indicated above do not cover commissioning spares.
5. Spares for Instruments shall be supplied along with the applicable accessories as mandatory spares. No accessories shall be supplied separately as mandatory spare.

22.7. INTERCHANGEABILITY & PACKING

All spares supplied under this contract shall be strictly interchangeable with the parts for which they are intended for replacements. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site. e.g. small items shall be packed in sealed transparent plastic bags with desiccators packs as necessary.

22.8. IDENTIFICATION

Each spare shall be clearly marked and labeled on the outside of the packing with its description. When more than one spare part is packed in a single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers, and other packages must be suitably marked and numbered for the purpose of identification.

22.9. CONTRACT-QUANTITIES

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The quantities & mandatory spares shall be as specified herein. Any other mandatory spares not listed above however required for any instrumentation item shall also be supplied by bidder. The final quantities may require addition/deletion during the contract stage. The Bidder shall furnish unit price for each mandatory spare under appropriate schedules which shall be used for adjusting the contract price in the event of addition/deletion from contract quantities specified herein.

22.10. DOCUMENTATION

Bidder shall furnish detailed catalogue, part number and subassembly/assembly drawings with manufacturer's cross reference for each spare part. The data and information furnished shall be of nature and content as per owner's approval to enable owner procurement of these spare parts directly from the respective manufacturer.

23. COMMISSIONING SPARES

For successful pre-commissioning, commissioning and performance testing, requirements of spares are to be provided by the contractor within quoted lump sum price and are to be listed in the bid. Any additional spares used shall be to Contractor's account. Any kind of spares required for start-up and commissioning including for replacement of faulty instruments shall be provided. Minimum 10% of each type of instrument fittings shall also be included as commissioning spare.

24. OPERATIONAL SPARES LIST

The Bidder shall furnish a list of recommended spares along with normal service expectancy period of frequency of replacement, quantity recommended for 3 years operation and unit rate against each item. The Owner shall place a separate order for such recommended spares as per the list finalized by the Owner, during detailed engineering and unit price indicated by the Bidder with his proposal.

Unless otherwise specified in the job specifications, all spares for 2 years of normal operation like gaskets, O-rings, diaphragms etc. as required for all instruments for two years of trouble free operation shall be quoted separately.

Unit rate of all items instruments, instrument cables, instrument valves manifolds and hardware shall be indicated by Bidder for any future addition/deletion for system related items. This price shall include all engineering charges, installation, software charges etc. related to the effected addition/deletion.

25. PACKING AND DISPATCH

Equipment shall be packed with suitable desiccants sealed in water-proof, vapour-proof wrapping, and packed in lumber or plywood enclosures, suitably braced tied and skidded. Lumber enclosures shall be solid, not slatted.

Review by the Owner of the Bidder's proposed packaging methods shall not relieve the Bidder of responsibility for damage or deterioration to the equipment and materials specified.

All equipment and materials shall be suitably coated, wrapped or covered end boxed or crated for moist humid tropical shipment and to prevent damage or deterioration during handling and storage at the site.

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All itemized list of contents shall be enclosed inside each case, and one other copy securely fastened to the outside of the case in a tin or light weight sheet metal envelope or pocket. The lists shall be plainly marked and placed in accessible locations to facilitate receipt and inspection. The packing list shall indicate whether shipment is partial or complete and shall incorporate the following information on each container, etc. according to its individual shipping number:

- a) Export case markings.
- b) Case number.
- c) Gross weight and net weight in Kilograms
- d) Dimensions in centimeters.
- e) Complete description of material including order number.

Electrical equipment controls and instrumentation shall be protected against moisture and water damage. All external gasket surfaces and flange faces, couplings, motor pump shafts, bearings and like items shall be thoroughly cleaned and coated with rust preventive compound as specified above and protected with suitable wood, metal or other substantial type covering to ensure their full protection.

26. PROPOSED BIDDER LIST

Refer Annexure -D

Note: This Bidder list is subject to customer approval

27. SCHEDULES

27.1. Schedule of Technical Confirmations – Schedule-A

(Please indicate Yes / No)

1.	All the items / equipments / instruments as per Enquiry / PID are included in the scope	
2.	All the items / equipments / instruments are manufactured and tested as per relevant codes and standards.	
3.	All the items / equipment / instruments meet Enquiry technical BHEL specification	
4.	Pre commissioning checks will be included in scope	
5.	Commissioning assistance included in the scope	
6.	Training at Bidder's works and at site included in scope	
7.	Makes of all instruments and equipment will be as per the BHEL specification	
8.	Site specific Programming assistance for purchaser's DCS included in scope	
9.	Calibration at manufacturer's works included in scope	
10.	Calibration at site included in scope	
11.	Supply of commissioning spares included in scope	
12.	Supply of Tools & tackles included in scope	
13.	Supply of hand held programmer kit / calibrator suitable for all instruments included in scope	

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14.	Supply of all calibration liquid, powder for calibrating instruments.	
15.	In the event of order all drawings datasheets and documents as per the BHEL specification will be submitted to BHEL for approval.	
16.	All instruments shall be provided with double compression type Nickel-plated brass cable gland and Annealed Tinned copper lugs	
17.	Operation and maintenance manual in required numbers will be supplied for all items	
18.	Erection materials like Root valves, 3 way manifolds, impulse piping required for installing all instruments will be included in scope	
19.	Supply of cable glands, lugs included in scope	
20.	Number of Digital inputs to be provided in DCS	Indicate quantity
21.	Number of Digital outputs to be provided in DCS	Indicate quantity
22.	Number of Analogue inputs to be provided in DCS	Indicate quantity
23.	Number of Analogue outputs to be provided in DCS	Indicate quantity
24.	Site support for auto operation through DCS as per Enquiry included in scope	
25.	Unit price for addition deletion as per Enquiry furnished in the Price Bid	

27.2. SCHEDULE OF TECHNICAL DEVIATIONS

SCHEDULE-B

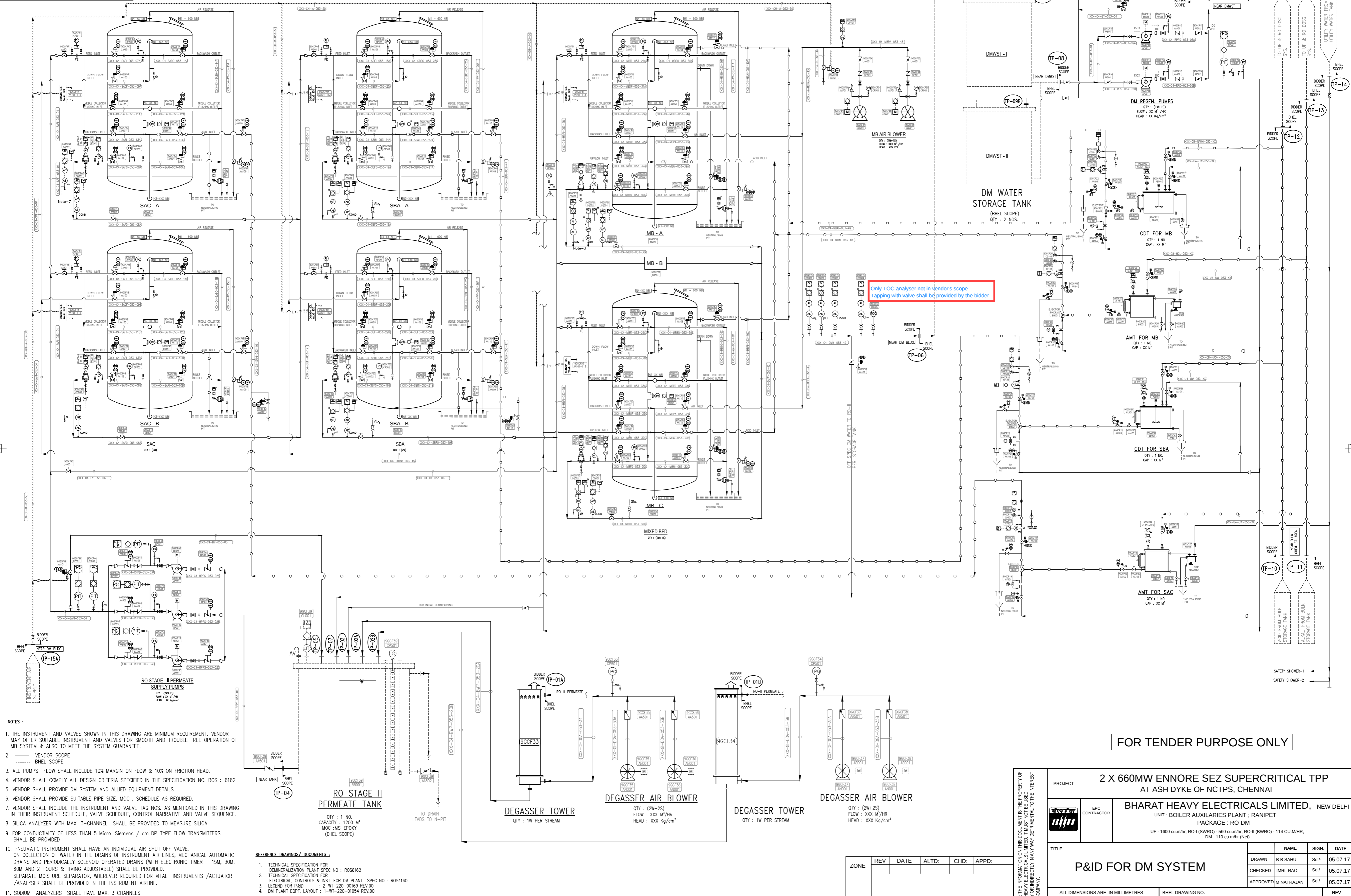
Spec. Clause no.	Specification requirement	Bidder's deviation statement

It is certified that except the deviation listed above, all other tender clauses are complied with.

Signature of the Bidder

Date:

1-WT-220-01053
DRAWING NO.



- NOTES :**
1. THE INSTRUMENT AND VALVES SHOWN IN THIS DRAWING ARE MINIMUM REQUIREMENT. VENDOR MAY OFFER SUITABLE INSTRUMENT AND VALVES FOR SMOOTH AND TROUBLE FREE OPERATION OF MB SYSTEM & ALSO TO MEET THE SYSTEM GUARANTEE.
 2. ——— VENDOR SCOPE
----- BHEL SCOPE
 3. ALL PUMPS FLOW SHALL INCLUDE 10% MARGIN ON FLOW & 10% ON FRICTION HEAD.
 4. VENDOR SHALL COMPLY ALL DESIGN CRITERIA SPECIFIED IN THE SPECIFICATION NO. ROS : 6162
 5. VENDOR SHALL PROVIDE DM SYSTEM AND ALLIED EQUIPMENT DETAILS.
 6. VENDOR SHALL PROVIDE SUITABLE PIPE SIZE, MOC, SCHEDULE AS REQUIRED.
 7. VENDOR SHALL INCLUDE THE INSTRUMENT AND VALVE TAG NOS. AS MENTIONED IN THIS DRAWING IN THEIR INSTRUMENT SCHEDULE, VALVE SCHEDULE, CONTROL NARRATIVE AND VALVE SEQUENCE.
 8. SILICA ANALYZER WITH MAX. 3-CHANNEL SHALL BE PROVIDED TO MEASURE SILICA.
 9. FOR CONDUCTIVITY OF LESS THAN 5 Micro. Siemens / cm DP TYPE FLOW TRANSMITTERS SHALL BE PROVIDED
 10. PNEUMATIC INSTRUMENT SHALL HAVE AN INDIVIDUAL AIR SHUT OFF VALVE. ON COLLECTION OF WATER IN THE DRAINS OF INSTRUMENT AIR LINES, MECHANICAL AUTOMATIC DRAINS AND PERIODICALLY SOLENOID OPERATED DRAINS (WITH ELECTRONIC TIMER - 15M, 30M, 60M AND 2 HOURS & TIMING ADJUSTABLE) SHALL BE PROVIDED. SEPARATE MOISTURE SEPARATOR, WHEREVER REQUIRED FOR VITAL INSTRUMENTS /ACTUATOR /ANALYSER SHALL BE PROVIDED IN THE INSTRUMENT AIRLINE.
 11. SODIUM ANALYZERS SHALL HAVE MAX. 3 CHANNELS

- REFERENCE DRAWINGS/ DOCUMENTS :**
1. TECHNICAL SPECIFICATION FOR DEMINERALIZATION PLANT SPEC NO : ROS6162
 2. TECHNICAL SPECIFICATION FOR ELECTRICAL CONTROLS & INST. FOR DM PLANT SPEC NO : ROS4160
 3. LEGEND FOR P&ID : 2-WT-220-00169 REV.00
 4. DM PLANT EQPT. LAYOUT : 1-WT-220-01054 REV.00

FOR TENDER PURPOSE ONLY

CAUTION: THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF BHEL. IT IS NOT TO BE REPRODUCED OR DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.

PROJECT		2 X 660MW ENNORE SEZ SUPERCRITICAL TPP AT ASH DYKE OF NCTPS, CHENNAI			
	EPC CONTRACTOR	BHARAT HEAVY ELECTRICALS LIMITED, NEW DELHI UNIT : BOILER AUXILIARIES PLANT ; RANIPET PACKAGE : RO-DM UP - 1600 cu.m/hr; RO-I (SWRO) : 560 cu.m/hr; RO-II (BWRO) : 114 CU.M/HR; DM : 110 cu.m/hr (Net)			
TITLE		NAME		SIGN.	DATE
P&ID FOR DM SYSTEM		DRAWN	B B SAHU	Sd/-	05.07.17
		CHECKED	IMRL RAO	Sd/-	05.07.17
		APPROVED	M NATRAJAN	Sd/-	05.07.17
ALL DIMENSIONS ARE IN MILLIMETRES		BHEL DRAWING NO.		REV	
PROJECTION 	SCALE	1-WT-220-01053		00	
N.T.S					

CAUTION: THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LIMITED. IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.

1-WT-220-01054
DRAWING NO.

ALL DIMENSIONS ARE IN MILLIMETRES

EQUIPMENT LIST:-

EQPT. NO	DESCRIPTION	QUANTITY	EQPT. DIMENSION IN MTR.(Approx.)	EQUIPMENT TAG NO	EQUIPMENT EMPTY WT.	EQUIPMENT WORKING WT.
01	DEGASSER TOWER	2W	VENDOR TO SPECIFY	DURING CONTRACT STAGE	VENDOR TO SPECIFY	VENDOR TO SPECIFY
02	DEGASSER AIR BLOWER	2W+2S				
03	RO-II PERM. SUPPLY PUMPS	2W+1S				
04	SAC	2W				
05	SBA	2W				
06	MIXED BED	2W+1S				
07	MB AIR BLOWER	1W+1S				
08	DM REGEN.PUMPS	1W+1S				
09	ACID MEAS.TANK FOR SAC	1W				
10	ALKALI MEAS.TANK FOR SBA	1W				
11	ACID MEAS.TANK FOR MB	1W				
12	ALKALI MEAS.TANK FOR MB	1W				

TERMINAL POINTS (TP)

TP NO.	ZONE	DESCRIPTION	FLANGE SIZE	APPROX. LOCATION		PIPE ELEVATION IN MTRS (APPROX.)
				NORTH/SOUTH	EAST/WEST	
TP-1A TP-1B TP-2A TP-2B		DEGASSER TOWER INLET	150 NB	DG TOWER INLET FLANGE		DURING CONTRACT STAGE
TP-3		RO-II PER. ST. TANK I/L	VENDOR TO SPECIFY	RO-II PER. ST. TANK I/L FLG		
TP-4		DM WATER I/L TO RO-II PER. ST. TANK (FOR INITIAL COMG.)		RO-II PER. ST. TANK I/L FLG		
TP-5		RO-II PER. SUPPLY PUMP SUCTION		RO-II PER. ST. TANK O/L FLG		
TP-6		RO-II PER. SUPPLY PUMP RECIR.		RO-II PER. ST. TANK I/L FLG		
TP-7		DM WATER O/L		APPROX. 20 M ON THE SOUTH SIDE OF DM BUILDING		
TP-8		OFF-SPEC DM WATER O/L		RO-II PER. ST. TANK I/L FLG		
TP-9A TP-9B		DM REGEN. PUMP SUCTION		DMWST OUTLET HEADER		
TP-10		DM REGEN. PUMP RE-CIR.		DM WATER STORAGE TANK I/L		
TP-11		ACID TRF. FROM BAST		NEAR CPU REGEN. BLDG.		
TP-12		ALKALI TRF. FROM BCST		NEAR CPU REGEN. BLDG.		
TP-13		ACID TAPPING FOR UF& RO DOSG.	25 NB	NEAR CHEM. DOSING BLDG		
TP-14		ALKALI TAPPING FOR UF& RO DOSG.	25 NB	NEAR CHEM. DOSING BLDG		
TP-15A		UTILITY WATER FOR SS AND FA	25 NB	NEAR CHEM. DOSING BLDG		
TP-15B		INSTRUMENT AIR SUPPLY	50 NB	NEAR CHEM. DOSING BLDG		
TP-15B		INSTRUMENT AIR SUPPLY	50 NB	NEAR DM TRF. PUMP HOUSE		

NOTES

- FGL (FINISHED GRADED LEVEL) OF RO-DM PLANT ELEVATION IS (-) 0.5 M .
- FGL (FINISHED FLOOR LEVEL) OF DM BUILDING AND DOSING BUILDING ELEVATION IS +0.0 M .
- EQUIPMENT SIZES OF EQUIVALENT CAPACITY HAVE BEEN CONSIDERED. HOWEVER VENDOR SHALL PROVIDE ACTUAL DIMENSION DURING CONTRACT STAGE.
- EQPT. LOCATION DIMENSIONS AND PIPE LINE ROUTING ARE SUGGESTIVE . IT MAY BE MODIFIED DURING CONTRACT STAGE AND TO SUIT SITE CONDITION.
- ACID AND ALKALI SHALL BE TRANSFERRED FROM THE BULK STORAGE TANKS TO THE AMT/CDT BY GRAVITY.
- TERMINAL POINT (T.P.) LOCATION MARKED IN THIS DRAWING ARE TENTATIVE. FINAL LOCATION SHALL BE CONFIRMED DURING CONTRACT STAGE.
- ALL THE CIVIL FACILITIES ARE IN BHEL SCOPE.

LEGEND :

FGL - FINISHED GRADED LEVEL	EF - EXHAUST FAN	CH - CHEMICAL RESISTANT TILED FLOOR
FFL - FINISHED FLOOR LEVEL	SS - SAFETY SHOWER	PL - PAVED LEVEL
PL - PAVED LEVEL	FA - FUME ABSORBER	DF - DWARF WALL - 1.2 M HT. FROM FFL
RS - ROLLING SHUTTER	TBL - TANK BOTTOM SLAB LEVEL	PT - PIPE TRENCH
DD - DOUBLE DOOR	VENDOR SCOPE	DC - DRAIN CHANNEL
D - SINGLE DOOR	BHEL scope	AT - AIR TILED DRAIN CHANNEL
		CT - CABLE TRENCH

FOR TENDER PURPOSE ONLY

PROJECT				2 X 660MW ENNORE SEZ SUPERCRITICAL TPP AT ASH DYKE OF NCTPS, CHENNAI			
Bharat Heavy Electricals Limited		EPC CONTRACTOR		BHARAT HEAVY ELECTRICALS LIMITED, NEW DELHI UNIT : BOILER AUXILIARIES PLANT ; RANIPET PACKAGE : RO-DM UF - 1600 cu.m/hr; RO-I (SWRO) - 560 cu.m/hr; RO-II (BWRO) - 114 CU.M/HR; DM - 110 cu.m/hr (Net)			
TITLE		NAME		SIGN.		DATE	
DM SYSTEM EQUIPMENT LAYOUT		B B SAHU		Sd/-		06.07.17	
		CHECKED		G RAJENDIRAN		Sd/-	
		APPROVED		M NATRAJAN		Sd/-	
ALL DIMENSIONS ARE IN MILLIMETRES		BHEL DRAWING NO.		REV			
PROJECTION		SCALE		1-WT-220-01054		00	
N.T.S							

CAUTION: THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LIMITED. IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.

ZONE	REV	DATE	ALTD.	CHD.	APPD.

