

5184/2020/PS-DEM-MAX

	TITLE:		SPECIFICATION NO. PE-TS-415-673-A001	
	1X660 MW BHUSAWAL THERMAL POWER STATION UNIT -6		SECTION : II	
	TECHNICAL SPECIFICATION FOR SEWAGE TREATMENT PLANT			
			REV. NO. 00	DATE :

SECTION – II

GENERAL TECHNICAL REQUIREMENTS

- SUB-SECTION IIA - GENERAL TECHNICAL REQUIREMENTS (MECH.)
- SUB-SECTION IIB - GENERAL TECHNICAL REQUIREMENTS (ELECTRICAL)
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SECTION – II

GENERAL TECHNICAL REQUIREMENTS

SUB-SECTION IIA - GENERAL TECHNICAL REQUIREMENTS (MECH.)

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TECHNICAL SPECIFICATION FOR PRESSURE & STORAGE VESSEL

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1.00.00 GENERAL

This section covers design requirements applicable for pressure vessel and atmospheric tanks for Sewage Treatment Plant. This section only indicates some of the minimum requirements which must be met, and the actual design of these vessels shall be better than these, if that is required from process considerations and code requirements.

2.00.00 GENERAL DESIGN FEATURES

2.01.00 Design

- 2.01.01 Design of all pressure vessels shall conform to ASME Section VIII or acceptable equivalent international standard. Design pressure shall be the maximum expected pressure to which the vessels may be subjected to plus 10% additional margin. Maximum expected pressure for vessels placed in the discharge line of pumps shall be based on the shut-off head of the pumps plus static head at pumps suction if any.
- 2.01.02 Design of all vertical cylindrical atmospheric storage tanks containing water, acid, alkali and other chemicals shall conform to IS: 803.
- 2.01.03 Design of all horizontal cylindrical atmospheric storage tank containing water, acid, alkali and other chemicals shall conform to BSEN: 12285.
- 2.01.04 Design temperature of all pressure vessels and storage tanks shall be 10 deg. C higher than the maximum temperature that any part of the vessel/tank is likely to attain during operation.
- 2.01.05 In case, tank is subjected to vacuum; the same shall be taken care in designing the tank.
- 2.01.06 All vessels / tanks without inside rubber lining shall have a corrosion allowance of minimum 2 mm and mill allowance (minimum 0.3 mm) for shell and dished ends. Thinning allowance of 2 mm (minimum) shall be considered for dished end. Vessel / tanks ends shall be of dished design and constructed by forging, pressing or spinning process. Conical or flat ends shall not be accepted. All dished ends shall be stress relieved.
- 2.01.07 All the atmospheric tanks shall have sufficient free board above the "Level High"/"Normal Level" as the case may be. The overflow level shall be kept at least 20 cm or 10% of vessel height above the "Level High"/"Normal Level" for all the tanks. Further, a minimum 300 mm free board shall be provided above the top of overflow level to the top of the tank. Wall thickness of atmospheric tanks shall not be less than 6 mm.
- 2.01.08 Vessels coming under preview of IBR shall be designed accordingly.
- 2.01.09 Interior surfaces of all tanks shall be clear of stiffeners and other structural supports. Tanks shall be reinforced and stiffened externally as required.

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- 2.01.10 All welds on inner tank surface shall be free of voids, gaps craters, pits, high spots, sharp edges, abrupt ridges and valleys or undercut edges. High spots, irregularities and sharp edges shall be removed by grinding. Inside weld seams shall be ground flush and smooth applicable for corrosion resistant coating or lining.
- 2.01.11 All internal baffles, wear plates, pipes etc. shall be continuously welded on both sides at all contact points with full fillet welds which shall be free of voids, gaps, craters, high spots, sharp edges, and undercutting. Sharp edges shall be ground to a 3 mm minimum radius.
- 2.01.12 Weld splatter shall be removed.
- 2.01.13 All welding shall be performed by ASME qualified welders under Section-IX of ASME Boiler and Pressure Vessel code and welding electrodes shall be as per relevant Codes/Standards viz. AISC Section 1.17 etc.
- 2.01.14 The plates for cylindrical tanks shall be accurately formed in bending rolls to the diameters called for, and the completed shells be concentric and plump. Plates shall be cold-rolled by plate bending machine in a number of passes to true curvature and joined by welding.
- 2.01.15 Vessels seam shall be so positioned that they do not pass through vessel connections.
- 3.00.00 MATERIAL OF CONSTRUCTION**
- 3.01.00 All pressure vessels shall be fabricated from carbon steel plates as specified in datasheet A of this specification and lined internally. All atmospheric tanks shall be fabricated of material as specified in datasheet A and lined internally.
- 4.00.00 APPURTENANCES**
- 4.01.00 Manholes**
- 4.01.01 All the pressure vessels and horizontal type storage tanks shall be provided with manhole of 500 mm diameter minimum size, preferably at the top head, complete with cover plate, lifting handle, davit cap, nuts, bolts, gaskets etc. to ensure leak tightness at the test pressure.
- 4.01.02 The vertical type storage tanks shall be provided with a manhole of 500 mm dia on the top cover, if the diameter of the tank is 1200 mm or more.
- 4.01.03 All the vessels and tanks shall be normally provided with a six inch gasketed handhole located near the bottom of the straight side.
- 4.01.04 The required lining/coating for the inside surface of the manhole/ handhole, nozzle and cover plate of the manhole/ handhole shall be same as that of the respective vessel/tank.

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4.02.00 **Lifting Lungs**

All vessels of diameter 1200mm or greater shall be provided with a minimum of 4 lifting lugs. Smaller vessels/ tanks shall be provided with at least 2 lifting lugs.

4.03.00 **Vessels Supports**

Adequate supporting arrangements like straps, saddles, skirt rings, or legs of steel shall be provided to transfer all loads to the respective skid structures.

4.04.00 **Vessel Internals**

The internals for pressure Vessels shall be designed for a low pressure drop to promote uniform distribution and flow through the vessels and to withstand the full design pressure of the vessel in both directions.

Specification requirements for vessel internals are as follows:

4.05.00 **Inlet water and Regenerant Distributors**

Hub and laterals with diffuser splash plates or header and perforated laterals. Material of construction shall be type 316 stainless steel, except for acid service which shall be of Hastelloy B.

4.06.00 **Underdrains**

Same as above with screened laterals with internal perforated pipes, and rubber-lined false bottom. For resin separation/regeneration/mixed resin vessels, it may have fully screened bottom (NEVA – clog type with para Septanurse screen, fully supported by subway grid, or equal).

4.07.00 For lined vessels, they shall also be lined in the same manner as the internal surfaces of these vessels. For the caustic diluent heating/storage tank, they shall be of type 304 stainless steel construction.

4.08.00 **Internal Fasteners**

All internal fasteners shall be of type 316 stainless steel and heavy duty locknuts shall be used throughout.

4.09.00 **Piping Connections**

4.09.01 All lined vessel connections and connections in unlined vessels 25 NB and larger shall be to ANSI 300 lb class. Flat face flanges shall be used throughout. Nozzle material shall be ASTM-A-106. Grade B. schedule 80 pipe. All flanged connections shall be supplied complete with matching counter flanges, nuts, bolts and full-face gaskets.

4.09.02 All vessel connections in unlined tanks smaller than 25 NB shall be screwed to ANSI 2.1 for schedule 80 pipe.

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5.00.00 SPECIFIC DETAILS

5.01.00 Atmospheric Tanks

Wall thickness of these tanks shall not be less than 6mm.

6.00.00 CODES AND STANDARDS

The design, manufacture, shop testing, site fabrication and erection, testing and commissioning of the pressure and storage vessels shall conform to the latest revisions of the following standards, in addition to other standards mentioned elsewhere in the tender document subject to any modification and requirement, as specified here in after.

- | | | | |
|----|---------|---|--|
| a) | IS: 803 | - | Code of practice for design, fabrication and erection of Vertical Mild Steel cylindrical welded oil storage tanks. |
| b) | IS: 816 | - | Code of practice for use of metal arc welding for general construction in mild steel. |
| c) | IS: 817 | - | Code of practice for training and testing of metal arc welders. |
| d) | IS: 822 | - | Code of procedure for inspection of welds. |
| e) | IS:1363 | - | Black hexagonal bolts, nuts and locknuts (dia 6 to 39 mm) and black hexagon screws (dia to 24 mm). |
| f) | IS:1367 | - | Technical supply conditions for threaded fasteners. |
| g) | IS:2062 | - | Specification for weld able structural steel. |
| h) | IS:2002 | - | Steel plates for pressure vessels for intermediate and High temperature service including boilers. |
| i) | IS:2825 | - | Code of unfired pressure vessels. |
| j) | IS:3133 | - | Manhole and inspection opening for chemical equipment. |
| k) | IS:4049 | - | Specification for formed ends for tanks and pressure vessels. |
| l) | IS:4682 | - | Code of practice for lining of vessels and equipment for chemical processes Rubber Lining. |
| m) | BS:2594 | - | Specification for carbon steel welded horizontal cylindrical storage tanks. |
| n) | ASME | - | Boiler and pressure vessel Section VIII code. |

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o) ASTM - American Society for Testing and Materials.

7.00.00 FABRICATION

7.01.00 The vessel ends for storage tanks of vertical type shall have flat bottom. However, the ends of horizontal storage tanks, and all the pressure vessels shall be dished design of Tori-spherical type designed.

7.02.00 The plates to be used for fabrication shall preferably have a minimum width of 1500 mm.

7.03.00 All the joints (circumferential / longitudinal) shall be continuous butt welded, inside and outside. Connection shall be flush with inner surface of tanks and welded continuously on both sides of shell. Sharp inside edges shall be rounded to a minimum 3 mm radius.

7.04.00 Welding sequence shall be adopted in such a way so as to minimize the distortion due to welding shrinkage. Contractor shall indicate in his drawing the sequence of welding proposed by him which should meet prior approval of the engineers. Welding shall not be carried out when the surface of the parts to be welded are wet from any cause and during periods of rain and high winds unless the welder and work are properly shielded.

7.05.00 All pressure vessels and storage tanks shall be fabricated complete and tested at manufacturer's works to ensure better workmanship.

7.06.00 Tank Connections

7.06.01 Bidder shall furnish all pipe material required for tank connection for the process requirement. In addition to these, additional connections, if required by the Owner for the inter-connection of their piping, instrumentation etc. shall also be provided. Such additional requirement will be intimated to the successful Bidder later and Contractor shall provide these fittings to match with the Owner's items. Adequate pipe support attachments in the external surface of the tank/vessel shall be provided for Owners pipes for all the vessels/tanks. All lined vessels connections shall be conforming to ANSI 300 lb class. Nozzle material shall be ASTM-106 Grade B, Schedule 80.

7.06.02 All flanged connections should be supplied complete with matching counter flanges, nuts bolts and gasket materials. The flange design, (thickness and drilling etc.) shall match with the interconnected piping flanges.

7.06.03 Bolts and nuts to be used externally to the vessels shall be of hexagonal head conforming to IS:1367. However, internal fasteners if any, shall be of SS:316 /SS-304 or Hastalloy-B as per the duty conditions.

7.06.04 Gaskets shall be of full face type.

7.07.00 Vessels Supporting Lifting Lugs

7.07.01 Adequate supporting arrangements like straps, saddles, skirt boards, pillars etc.

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shall be provided to transfer all loads to civil foundation. All foundation bolts, inserts etc. shall also be provided.

- 7.07.02 All vessels of internal, diameter of 1200 mm or greater shall be provided with minimum four (4) lifting lugs for safe and effective handling during erection. Smaller vessels shall be provided with at least two (2) lifting lugs.
- 7.07.03 Material of construction for these vessel supports, saddles, lugs shall conform to IS:2062 of tested quality.
- 7.08.00 **Special Accessories Storage Tanks**
- 7.08.01 Vessel internals wherever required shall be provided as detailed out elsewhere in the specification.
- 7.08.02 All the pressure vessels and tanks shall be provided with drain connections along with drain valves of suitable size. Further all the atmospheric storage tanks shall be provided with over flow connection designed for the filling rate of the respective tank.
- 7.08.03 All the pressure and tanks shall be provided with the vent connections. The design shall be as to offer adequate area for venting. Venting area shall be such that over pressure/vacuum is not created in the tank during maximum filling/drain-off rate. The maximum draw off rate for the DM storage tanks shall be intimated later to the successful bidder.
- 7.08.04 Various instrumentation and the fittings required for the same shall be supplied as elaborated in data sheets.

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1.0 <u>GENERAL INFORMATION</u> 1.1 This section presents the general guidelines and details of Horizontal Centrifugal Pumps to be procured and shall not be limited to the pumps specified under. For other horizontal centrifugal pump, these general guidelines as specified hereinafter shall be followed. 2.0 <u>CODES AND STANDARDS</u> 2.1 The design, manufacture and performance of the Horizontal Centrifugal Pumps as specified hereinafter, shall comply with the requirements of the following codes and standards and shall include all the latest amendments subsequent to the year of publication as mentioned below. 2.1.1 IS-6595 Part-2/1993 : Horizontal Centrifugal pumps for clear, cold and fresh water. 2.1.2 IS-5120/1977 : Technical requirements for Rotodynamic special Purpose pumps 2.1.3 IS-5639/1970 : Pumps for handling chemicals & corrosive liquids 2.1.4 IS-5659/1970 : Pumps for process water 2.1.5 IS-6536/1972 : Pumps for handling volatile liquids 2.1.6 IS-9137/1978 : Code for acceptance tests for centrifugal, mixed flow and axial flow pumps – Class 'C' 2.1.7 BS EN ISO 9906: 2000 : Acceptance tests for Centrifugal, mixed flow and axial flow pumps – Class 'B' & 'C' Tests 2.1.8 API-610/1989 : Centrifugal pumps for general refinery services. 2.1.9 Standards of the Hydraulic Institute of USA (1983)		

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PTC 8.2/1965 : Power Test Codes – Centrifugal pumps.		
2.2	In case of any contradiction with the above standards and Datasheet – A, the stipulations in the Datasheet – A shall prevail and shall be binding to the Contractor.	
3.0	<u>SCOPE OF WORKS</u>	
3.1	<u>SCOPE OF SUPPLY</u>	
3.1.1	The scope of supply under this section shall be as below. Items specifically not mentioned but deemed necessary by the Bidder for making the system completely reliable and efficient shall also be included.	
(a)	Equipment	
(i)	DMCW Pumps (Turbine Island)	Three (3) Horizontal Centrifugal Pumps and drives complete with all accessories as specified in this section and in the Datasheet – A attached with this section.
(ii)	DMCW Pumps (Boiler Island)	Two (2) Horizontal Centrifugal Pumps and drives complete with all accessories as specified in this section and in the Datasheet – A attached with this section.
(iii)	Cycle make-up Pumps	Two (2) Horizontal Centrifugal Pumps and drives complete with all accessories as specified in this section and in the Datasheet – A attached with this section.
(iv)	Boiler Fill Pumps	Two (2) Horizontal Centrifugal Pumps and drives complete with all accessories as specified in this section and in the Datasheet – A attached with this section.
(v)	Any other Horizontal Centrifugal Pump(s) included by the Bidder.	

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(b) Equipment Accessories Each pump set for all the above groups shall be supplied with the following accessories: (i) Couplings of approved design to connect pump shaft directly with the motor shaft. (ii) Sets of base plates, support plates, grounding pads, lifting lugs, eye bolts, nuts etc for each pump and motor set. (iii) Slip-on type drilled steel flanges of proper rating for both suction and discharge connections of each pump set. All the counter-flanges shall be complete with requisite number of bolts, nuts, gaskets etc. (iv) Air release cocks and drain plugs for each pump set. (v) Discharge line pressure gauge and suction line pressure/ vacuum gauges complete with isolating cocks for each pump set. (vi) All internal/integral piping with valves, fittings, and pressure gauges for lubrication, cooling and sealing, wherever applicable, shall be tapped of directly from respective pump discharge. 3.2 For details regarding scope of services and works, Volume II of this specification shall be referred to. 4.0 <u>PERFORMANCE REQUIREMENT</u> 4.1 Performance requirements for the pumps shall be as guided in Section-I of this volume and by the Datasheet – A enclosed with this section. 4.2 Pumps shall preferably be designed to have the best efficiency at the specified duty point. The pumps shall be suitable for continuous operation at any point within the “Range of Operation” as stipulated in the Datasheet – A attached with this section.		

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4.3	Pumps shall preferably have continuously rising head-capacity characteristics from the specified duty point towards shut-off point, the maximum being at shut-off to enable parallel operation. Under all circumstances, the 'Range of Operation' of the pumps shall exclude any unstable operating zone of the head – capacity curve.	
4.4	Wherever specified in the Datasheet – A attached with this section, pumps of each category shall be suitable for parallel operation. The head vs capacity, the BHP vs capacity characteristics etc shall be identical to ensure equal load sharing and trouble-free operation of any pump when the other pump (s) working in parallel with it, trips.	
4.5	The pump set along with the drive motor shall run smooth without undue noise and vibration. Acceptable peak to peak vibration limits shall be generally guided by the Hydraulic Institute Standards of USA.	
5.0	<u>DESIGN AND CONSTRUCTION</u>	
5.1	<u>PUMP CASING</u>	
5.1.1	Pump casing shall be provided with adequate number of vents and priming connections with valves unless the pump is made self-venting and priming. Casing drain, as required, shall be provided complete with drain valves.	
5.1.2	Pump design must ensure that the nozzles are capable of withstanding external reactions not less than those specified in API-610.	
5.1.3	In cases where an expansion joint is located at pump discharge, the pump assembly will be subjected to an additional thrust which will be transmitted to the foundation. This additional thrust shall be taken into the consideration for pump design.	
5.2	<u>IMPELLER</u>	
5.2.1	The rotor assembly shall be dynamically balanced and designed with critical speed substantially above the operating speed.	

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5.3	<u>WEARING RINGS</u>	
5.3.1	Replaceable type wearing rings shall be furnished to prevent damage to impeller and casing.	
5.4	<u>SHAFT</u>	
5.4.1	Shaft size shall be selected considering that the critical speed shall be away from the operating speed as recommended in applicable Code/Standard. The critical speed shall also be at least 10% away from runaway speed.	
5.5	<u>SHAFT SLEEVES</u>	
5.5.1	Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the other faces of gland packing or seal end plate so as to distinguish between the leakage past shaft and shaft sleeve and that past the seals/glands.	
5.5.2	Shaft sleeves shall be properly fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.	
5.6	<u>BEARINGS</u>	
5.6.1	Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearing housing.	
5.6.2	Heavy duty sleeve/ball/roller type bearings shall be provided to take care of the radial loads.	
5.6.3	In case of sleeve type radial bearings, axial thrust shall be absorbed in suitable hydraulic devices and/or thrust bearings.	
5.6.4	Bearings and hydraulic devices (if provided for balancing axial thrust) shall be of adequate design for taking the entire pump load arising from all probable conditions of continuous operation, as specified in the Datasheet – A. Life of the bearings shall be guided by the design standard of the	

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pump or as specified in Datasheet – A. Thrust bearing shall be capable of running continuously at maximum load.		
5.6.5	The bearings shall be oil/grease lubricated. Suitable lubricating arrangement for the bearings shall be furnished with the pump complete with all accessories like pump, filters, pipings, fittings, valves, interlocking and supervising instruments etc as necessary and specified in the Datasheet – A. The design shall be such that the bearing lubricant does not contaminate the liquid being pumped.	
5.7	<u>STUFFING BOXES</u>	
5.7.1	Stuffing box design shall permit replacement of packing without removing any part other than the gland.	
5.7.2	Stuffing boxes shall be sealed/cooled by the fluid being pumped/external clear water, as specified in the Datasheet – A. All necessary pumps, piping, fittings, valves, instruments etc as required for safe and trouble-free operation of the pumps and as specified in the Datasheet – A shall be provided.	
5.8	<u>MECHANICAL SEALS</u>	
5.8.1	Mechanical seals shall be provided for all pumps. The pump supplier shall co-ordinate with the seal maker in establishing the circulation rate for maintaining a stable film at the seal face in the chamber. The seal piping system shall form an integral part of the pump assembly.	
5.8.2	When handling liquids near their boiling point, suitable arrangement for external cooling shall be provided so as to prevent flashing at the seal faces.	
5.8.3	For the seals under vacuum service, the seal design must ensure sealing against atmospheric pressure, even when the pumps are not operating.	
5.9	<u>DRIVE UNIT</u>	
5.9.1	The pumps shall be driven by electric motor or other driving equipment like diesel engine etc directly coupled or through a gear box/belt drives, as	

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specified in the Datasheet – A. A heavy-duty coupling along with coupling guard shall be provided between the pump and drive unit (except for belt drives). 5.9.2 Unless otherwise specified in Datasheet – A, drive unit power rating shall be the larger of the following requirements. (a) 10% margin over the pump shaft input power at the rated duty point. (b) 5% margin over the maximum pump shaft input power required within the 'Range of Operation'. (c) Pump shaft input power required considering the overloading of the pump assuming single pump operation in the event of tripping of one or more of the pumps operating in parallel.		

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1.0 GENERAL INFORMATION

The general guidelines as illustrated in the subsequent clauses of this section shall be applicable for all vertical pumps to be installed by the Bidder.

2.0 CODES AND STANDARDS

2.1 In addition to the requirements spelt out in Volume II of this specification, the equipment to be provided under this section shall specifically conform to the following codes, standards, specifications and regulations, as applicable, including all the latest amendments subsequent to the year of publication as mentioned below.

2.1.1	IS 1710/1989	:	Vertical Turbine Mixed & Axial flow Pumps for Clear, Cold and Fresh Water.
2.1.2	IS 5120/1977	:	Technical requirements - Rotodynamic special purpose pumps.
2.1.3	IS 5639/1970	:	Pumps for handling chemicals and corrosive liquids.
2.1.4	AWWAE 101 (ANSI B58-1)	:	Vertical Turbine Pumps – Line Shaft and Submersible Types.
2.1.5	IS 5659/1970	:	Pumps for process water
2.1.6	IS 6536/1972	:	Pumps for handling volatile liquids.
2.1.7	IS 9137/1978	:	Code for acceptance for centrifugal, mixed flow and axial flow pumps - Class 'C'.
2.1.8	BS EN ISO 9906: 2000	:	Acceptance tests for Centrifugal, mixed flow and axial flow pumps – Class 'B' & 'C' Tests
2.1.9	ANSI B 73.2M/ 1984	:	Vertical inline centrifugal pumps for chemical process.

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2.1.10	API 610/1989	: Centrifugal pumps for general refinery services.	
2.1.11	Hydraulic Institute Standards of USA (1983)		
2.1.12	PTC 8.2/1965	: Power Test Codes - Centrifugal pumps	
2.1.13	Other accepted Standards like DIN/JIS/GOST etc, which may be equivalent or superior to those specified above.		
2.1.14	In case of any contradiction between the above standards and Datasheet - A attached to this section, the stipulations in the Datasheet - A shall prevail and shall be binding on the Contractor.		
3.0	<u>SCOPE OF WORKS</u>		
3.1	<u>SCOPE OF SUPPLY</u>		
3.1.1	The scope of supply under this section and pertaining to 1 x 660 MW Unit shall be as below. Items not specifically mentioned but deemed necessary by the Bidder for making the system completely reliable and efficient shall also be included.		
	(a) Equipments		
	(i) ACW Pumps : Two (2) (One working + One Standby) Vertical Wet Pit type Auxiliary Cooling Water (ACW) Pumps complete with electric motor drives together with all other accessories as specified and corresponding to the ratings obtained in strict conformance with the guidelines specified.		
	(ii) Any other vertical pump to be installed by the Contractor.		
	(b) Equipment Accessories		
	Each pump set for all the above groups shall be supplied with the following accessories, as applicable.		

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(i) Heavy-duty couplings of approved design to connect the pump shaft directly with the motor shaft. (ii) Sets of base plates, support plates, grounding pads, thrust blocks, fitting lugs, eyebolts, nuts etc for each pump and motor set. (iii) Slip on type drilled steel counter flanges of proper rating to suit the discharge flange of each pump set. All the counter flanges shall be complete with requisite number of bolts, gaskets etc. (iv) Thrust pads, if required, for pump discharge head complete with all necessary fixing and bolting arrangement, fasteners etc. (v) One (1) pressure indicator with isolating cocks at the discharge side of each pump; Two (2) additional stubs with isolating root valves for pressure tapings and Two (2) thermo wells for temperature tapings at the discharge side of each pump for performance testing. Thrust bearing shall be furnished with dial type thermometer, temperature switch for high temperature annunciation and oil level gauge. (vi) All internal/integral piping with valves, fittings and instruments for lubrication, cooling and sealing, if applicable, shall be tapped off from respective pump discharge. 3.2 For detailed scope of services and works, Volume II of this specification shall be referred to. 4.0 <u>PERFORMANCE REQUIREMENTS</u> 4.1 Performance requirements for the pumps shall be as specified in Datasheet – A. 4.2 Pumps shall preferably be designed to have the best efficiency at the specified duty point. Further, the pumps shall be suitable for continuous operation at any point within its `range of operation.		

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4.3	Pumps shall preferably have continuously rising head-capacity characteristics, with maximum head at pump discharge shut-off, to enable parallel operation. Power capacity characteristics shall preferably be non-overloading type. Under all circumstances, the 'range of operation' of the pumps shall exclude any unstable operating zone of the head-capacity curve.	
4.4	For parallel operation of the pumps, pump shall have identical characteristics to ensure equal load sharing and shall ensure trouble-free operation of any pump when the other pumps, working in parallel with it trips.	
4.5	The pump and motor shall be designed to withstand run away speed attained with reverse rotation caused by reverse flow continuously in case the device provided to prevent the reverse rotation fails.	
5.0	<u>DESIGN AND CONSTRUCTION</u> Pumps shall be of vertical shaft, complete with bowl, column pipe, discharge head and base plate with all accessories. General design and constructional features of the pumps shall be as follows:	
5.1	<u>BOWL ASSEMBLY</u>	
5.1.1	This shall be either a single or multi-stage centrifugal, mixed flow or axial flow type with discharge co-axial with shaft. Type of impeller shall be chosen on the basis of the pump specific speed and the characteristics of handling fluid.	
5.1.2	Pumps shall have provision for adjustment of impellers in vertical direction from an accessible location, preferably at the housing (where separate thrust bearing for the pump is provided). The adjustment mechanism must take into consideration the extension of the line shaft due to hydraulic down thrust, weight of the shaft and impeller.	

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5.2	<u>DISCHARGE HEAD</u> In case, expansion joint is to be used at the pump discharge, pump base plate shall either be adequately designed to take the unbalanced forces and moments from the use of such expansion joint or a separate thrust block at the pump discharge head shall be provided to transmit these forces to the external supporting structure. Calculation of thrust load shall be done considering the highest pressure seen by the pump and internal diameter of the arch of the expansion bellow.	
5.3	<u>COLUMN PIPE</u> 5.3.1 Column pipe shall be flanged have bolted connection and shall be designed for full internal vacuum. 5.3.2 In case pump discharge, is below the floor level and the water level is at or above the discharge valve level, the column pipe piece located at the intermediate floor level shall be provided with suitable floor sealing device. 5.3.3 In case of multi-piece column pipe and shaft assembly, the design shall permit raising/lowering of the pump assembly piece by piece without any difficulty. Any fixtures, clamps etc necessary for such purpose shall be supplied by the Contractor under this section. The Contractor shall also submit a write-up describing clearly the procedure of handling the pump.	
5.4	<u>IMPELLER SHAFT, LINE SHAFT AND HEAD SHAFT</u> 5.4.1 Shaft size shall be selected on the basis of maximum torque to be applied on the pump shaft. 5.4.2 Critical speed of the shaft shall be sufficiently away from the pump operating speed and in no case shall lie between 90% and 110% of the rated speed. 5.4.3 Impeller shaft shall be guided by bearings provided in each bowl or above and below the impeller shaft assembly. The butting faces of the shaft shall be machined square to the assembly and the shaft shall be chamfered at the edges.	

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5.4.4	Line shaft may be of single or multiple pieces as required. In case of multiple pieces, line shaft shall be coupled as per the standard practice of the manufacturer. For screwed coupling, screw directions shall permit tightening of the joint during pump operation.	
5.4.5	Replaceable shaft sleeves shall be furnished at applicable locations, particularly under stuffing box and at other locations, as considered necessary.	
5.5	<u>SHAFT ENCLOSING TUBE</u> Shaft enclosing tube shall be required, unless self lubricated (and cooled) type of shaft bearings is asked for. Length of the shaft enclosing tube shall be in conformity with the shaft piece lengths.	
5.6	<u>STUFFING BOX</u> Stuffing boxes shall be of sufficient depth to accommodate ample packing. The packing glands shall be split type to facilitate repacking of the boxes. The space between the motor and the stuffing box shall be sufficient to permit removal of the packing gland and insertion of packing without dismantling the pump.	
5.7	<u>COUPLING</u> Bolts and nuts of the coupling between pump and the motor shaft shall have locking device to prevent the nuts from becoming loose during rotation at normal and reverse direction. Suitable arrangement shall be provided to adjust the vertical clearance of impeller. Bidder shall furnish necessary details of a proven arrangement in the offer. Coupling shall be flexible type if thrust bearing are provided at both pump body and motor and shall be rigid type if thrust bearing is provided only at the motor.	
5.8	<u>BASE PLATE</u> Base plate of each pump shall be of heavy structural steel. Separate heavy steel sole plates (or curb rings) shall be provided for grouting and shall be	

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designed to permit removal of entire pump along with discharge head and base plate without disturbing the sole plate or grout. The sole plate shall be blast cleaned to a clear white finish. Base plate and pump supports shall be so constructed and the pumping unit so mounted as to minimise misalignment and withstand hydraulic thrust. Pump foundation base plate shall be stress relieved and machined after welding. 80% blue matching for contact surface shall be provided by the pump manufacturer/bidder between pump sole/foundation plate and bottom surface of motor skirt flange. Similarly, 80% blue matching for contact surface shall be ensured by the bidder between top surface of flange of motor skirt and bottom surface of motor flange. All metal to metal contact surfaces for pump shall be provided with 80% blue matching prior to offering the equipment for inspection & testing.		
5.9	<u>BEARINGS</u>	
5.9.1	Shaft Bearings	
Adequate number of properly designed bearings shall be provided for smooth and trouble-free operation of the pump. Number of bearings shall consider the number of shaft pieces used and the critical speed of the shaft. Bearings shall be either lubricated by external clear water/oil/grease or self lubricated as specified in the Datasheet - A. In case of external water/oil lubrication, complete lubrication arrangement shall be furnished with the pump. Pre-lubrication of the shaft bearings, pre-lubrication tank and other accessories shall be within the scope of supply of the Bidder/Contractor.		
5.9.2	Thrust Bearing	
Thrust bearing of adequate size and capacity shall be provided to take the vertical thrust of the impeller arising out of the pump operation and dead weight of the rotating components. Life of the thrust bearing shall be guided by the design standard of the pump. Thrust bearing shall be capable of running continuously at maximum load.		

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Thrust bearings shall be either grease or oil lubricated. Lubrication arrangement shall be such that the lubricant does not contaminate the handling fluid. The arrangement shall also be adequate to protect the bearing, while the pump coast down to stop in case of power failure of the station. Pre-lubrication of the thrust bearing, if recommended by the pump manufacturer, shall be taken care of in designing the lubrication system. Cooling of the thrust bearing, if necessary, shall be done by the handling fluid/external water. Location of the thrust bearing may be at the pump body or at the driver, or at both depending on the requirement of Datasheet - A or as per the recommendation of the pump manufacturer (and approved by Owner). 5.10 <u>REVERSE ROTATION</u> 5.10.1 The pump impeller and other rotating components shall be designed for reverse rotation, when subject to reverse flow at rated pump discharge head. 5.11 <u>DRIVE UNIT</u> 5.11.1 The pump shall be driven by electric motor. A heavy duty coupling shall be provided between the drive unit and the driven equipment (except for belt drive). 5.11.2 Unless otherwise specified in Datasheet - A, drive element power rating shall be the maximum of the following requirements. (a) 10% margin over the pump shaft input power at the rated working condition. (b) 5% margin over the maximum pump shaft input power required within its operating range including the shut off point. (c) Pump shaft input power required considering overloading of the pump assuming single pump operation in the event of tripping of the other pump(s) operating in parallel.		

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(d) Shaft input power required to bring the pump to its rated condition (or any point in its working range) while the pump is in reverse rotation due to reverse flow of the fluid at rated head with the discharge butterfly valve partially open as per the start-up logic and the other adjoining pump running. 5.11.3 The drive equipment shall preferably be air-cooled. In case the pumping fluid is water, free of abrasive and corrosive matter, the same can be used for cooling purpose. The arrangement shall be within the scope of the supplier.		

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	TITLE: 1X660 MW BHUSAWAL THERMAL POWER STATION UNIT -6	SPECIFICATION NO. PE-TS-415-673-A001
		SECTION - II
	TECHNICAL SPECIFICATION FOR SEWAGE TREATMENT PLANT	SUB-SECTION - II A
		REV.NO. 0 DATE:

**TECHNICAL SPECIFICATION FOR
METERING PUMPS**

5184/2020/PS-PEM-MAX

	TITLE:	SPECIFICATION NO. PE-TS-415-673-A001
	1X660 MW BHUSAWAL THERMAL POWER STATION UNIT -6	SECTION - II
		SUB-SECTION - II A
	TECHNICAL SPECIFICATION FOR SEWAGE TREATMENT PLANT	REV.NO. 0 DATE:

1.00.0 GENERAL

- 1.01.01 Specification cover the design, material, construction features, manufacture, inspection, testing the performance at the vendor's/sub-vendor's works, delivery to site, erection, commissioning and testing of metering pumps.

2.00.0 GENERAL DESIGN FEATURES

- 2.00.01 Pumps shall be simplex positive displacement hydraulically operated diaphragm design, driven by squirrel cage induction motor through suitable speed reduction unit. Maximum pump stroke speed shall not exceed 100 per minute.
- 2.00.02 The stroke shall be continuously adjustable to give a capacity variation 0-100% range while the pump is running or stopped. Adjustment of capacity shall be done by manual control facility (micrometric adjusting type) to be provided locally for each of the pump.
- 2.00.03 The stroke shall be continuously adjustable to give a capacity variation 0-100% range while the pump is running or stopped. Adjustment of capacity shall be done by manual control facility (micrometric adjusting type) to be provided locally for each of the pump.
- 2.00.04 Capacity variation may be effected by changing eccentricity of the driving crank or by suitable hydraulic circuit. Pump accuracy shall be industry standard $\pm 1\%$ of capacity setting.
- 2.00.05 Pumps shall be provided with an integral relief valve, spring operated to release pressure when delivery line blockage occurs.
- 2.00.06 Crankcase shall be constructed of high quality cast iron, which will also house the gearbox and guides of cross head.
- 2.00.07 Guided, controlled travel, double-ball check valves or equivalent, shall be provided both on the suction and discharge side.
- 2.00.08 Material of construction of the various parts shall be as per the details furnished elsewhere in the specification. However, all parts coming in contact with acid shall be of Haste alloy 'B' and for alkali it should be of SS-316 only.
- 2.00.09 Suitable gland seal shall be provided to prevent leakage.
- 2.00.10 Electric drive motor particulars should follow enclosed electrical chapters.

3.00.00 TESTING**3.01.00 Testing and Inspection at Manufacturer's Works**

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	TITLE:	SPECIFICATION NO. PE-TS-415-673-A001
	1X660 MW BHUSAWAL THERMAL POWER STATION UNIT -6	SECTION - II
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- 3.01.01 The manufacturer shall conduct all tests required to ensure that the equipment furnished conforms to the requirements of this Specification and is in compliance with requirements of the applicable codes. The particulars of the proposed tests and the procedures for the tests shall be submitted to Owner for approval before conducting the tests.
- 3.01.02 The Owner's representatives shall be given full access to all tests for which the Manufacturer shall inform the Owner allowing adequate time so that if the Owner so desires, his representatives can witness the test.
- 3.01.03 All materials and castings used for the equipment shall be of tested quality. The test certificates shall be made available to Owner.
- 3.01.04 The pump casing shall be hydraulically tested at 200% pump operating pressure or 150% of design pressure whichever is higher. The test pressure shall be maintained at least for ½ an hour.
- 3.01.05 The rotating parts of pump drive shall be subjected to static balancing.
- 3.01.06 All pumps shall be tested at the shop for capacity, volumetric accuracy, repetitive accuracy, power and volumetric efficiency. The tests are to be done according to the requirements of the "Hydraulic Institute" of U.S.A. and Indian Standards as applicable.
- 3.01.07 The pump accessories e.g. gear box, speed reduction unit etc. will be subjected to tests as per manufacturer's standards. The test results shall be furnished to the Owner.
- 3.01.08 The combined variation of the pump and motor should be restricted within limits specified by Hydraulic Institute Standard, USA when the pump operated singly or in parallel.
- 3.01.09 All pumps shall be subject to strip down examination visually to check for mechanical damages after performance testing at shop.
- 3.01.10 Diaphragm of the metering pump shall be type tested as per applicable code/standard.
- 3.01.11 Performance test shall be carried out for the setting of pressure relief valve.
- 3.01.12 Test reports and certificates of all the above-mentioned tests to ensure satisfactory operation of the system shall be submitted to the Owner for approval before dispatch.

3.02.00 Test at Site

After erection at site pumps as detailed under different groups shall be operated to prove satisfactory performance as individual equipment as well as a system. If the performance at site is found to be not to the requirements, then the equipment shall be rectified or replaced by the Vendor at no extra cost to the Owner.

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1.0 <u>GENERAL INFORMATION</u> 1.1 Sump pumps specified hereinafter shall be used to dewater various sump pits in the power house and other plant area where gravity draining will not be envisaged and to ensure general housekeeping. 1.2 Pumps under this specification have been divided into following four (4) groups according to different duty envisaged and location of sumps/pits. 1.2.1 Group –A The Group-A pumps shall be electric motor driven permanently installed vertical wet pit bottom suction volute type and will handle drainage water, containing solid particles with sludge, polluted liquid etc. from the area where they are installed. These pumps will run continuously by the use of high and low level switches in the sump. Particle size in the water will not exceed 15 mm. These pumps shall be provided to all indoor sumps of the plant and outdoor sumps of capacity 5 m³ and above. The electrical equipment for these pumps (motor, starter cabinet) shall be fireproof design. The type test certificates for fire proof electrical equipment to be furnished. The cable for these pumps shall be fire survival cables. 1.2.2 Group-B These pumps shall be horizontal centrifugal electric motor driven portable type. Each pump set along with control panel etc. shall be mounted on a trolley for ease of transportation. These pumps shall be suitable for handling drainage water containing hard solid particles, sludge, polluted liquid, significant amount of fuel oil/LDO etc. and particle size will not exceed 20 mm. These types of pumps shall be used in different plant areas e.g. fuel oil unloading and transferring pump house. All the electrical equipment such as Motors, Starter cabinet etc shall be fireproof design. Type test certificate for fire proof electrical equipments shall be furnished. The cables of these pumps shall be fire survival type.		

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1.2.3	Group-C The Group - C pumps shall be vertical submersible portable type pump motor sets with suitable arrangement for carrying to any place and for lowering to and raising from various water reservoirs and pits. The pump motor set shall be suitable for handling water containing mud's/sludge, solid particles, cotton waste, silica, ash particles, coal particles, polluted liquid etc. The particle size in water will not exceed 20 mm. These pumps will be utilised to dewater various deep sumps/pits (e.g. CT blow down tank, clarified water pump house, raw water pump house, CW pump house) in case of any eventuality. 1.2.4 Group-D These pumps shall be similar to Group - A pumps except that these pumps will be used to handle water containing solid particles, sludge, ash polluted liquids etc. Particle size in the water will not exceed 25 mm. These pumps should be installed in the sumps/pits at the locations such as: (a) E.S.P. Control Room Building (b) AHP Control Building (c) Ash Slurry Pump house (d) HCSD Pump house These pumps shall also be provided to all other indoor sumps and outdoor sumps of capacity 5 m³ and above present in the Ash Handling plant. NOTE: Total numbers and rating of all the groups of sump pumps are given in Datasheet -A enclosed with this specification. 2.0 <u>CODES AND STANDARDS</u> 2.1 The design, manufacture and performance of the sump pumps and drives specified, hereinafter, shall comply with the requirements of all applicable codes, the latest applicable Indian/British/American/DIN Standards, in particular the following:	

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2.1.1	IS-1710	:	Vertical Turbine Pumps for clear cold and fresh water.
2.1.2	IS-5120	:	Technical Requirements – Rot dynamic special purpose pumps.
2.1.3	IS-5600	:	Sewage and drainage pumps.
2.1.4	IS 8034	:	Submersible pumps sets
2.1.5	HIS	:	Hydraulic Institute Standards of USA
2.2	The materials of the various components shall conform to the applicable IS /BS/ASTM/DIN Standards.		
3.0	<u>GENERAL PERFORMANCE REQUIREMENT</u>		
3.1	The pumps shall be designed to have best efficiency at the specified duty point. The pump set shall be suitable for continuous operation at any point within the "Range of Operation" as stipulated by the manufacturer.		
3.2	Pumps shall have a continuously rising head capacity characteristics from the specified duty point towards shut off point, the maximum head being at shut off.		
3.3	Permanently installed vertical pumps shall be suitable for parallel operation. The Head vs Capacity, the BHP vs Capacity characteristics etc shall match to ensure equal load sharing and trouble free operation throughout the range. Drive Motor shall not be overloaded when pump discharge is more than rated condition.		
3.4	The static head requirement of portable submersible type sump pump may have a considerably wide range of variation depending upon the depth of pit being dewatered. While the pump shall have adequate capacity at the maximum head, the motor shall be sufficiently rated to cater for any overloading during the pump operation at its minimum possible head i.e. maximum discharge.		
3.5	Pump motor set shall run smooth without undue noise and vibration. Acceptable peak to peak vibration limits shall generally be guided by Hydraulic Institute Standards (latest edition).		

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4.0 <u>SCOPE OF WORK</u> 4.1 Pumps under groups A, B, C, and D as listed in the Datasheet -A along with drive motors, couplings and other accessories mentioned below, as also those needed to make the pump-motor sets complete in all respect, for proper operation and maintenance. All motors in outdoor duty shall be provided with IP-55 enclosure. The accessories shall include among other things of the following : 4.2 For the vertical Group - A sump pump motor sets 4.2.1 Discharge of sump pump shall be led to the nearest surface drain, Common Effluent Treatment Drain (CETD) & oil water separator respectively. This shall include a non-return valve and an isolating valve for each pump, necessary pipes, fittings, flange connections and counter flange with bolts, nuts and gaskets. 4.2.2 A common base frame for the purpose of supporting the pump motor sets in each sump, utilising embedded curb angle around the top of the sump. The base frame shall also be used to support each discharge piping. 4.2.3 Three (3) electrode type capacitance level switches per sump; one for low level, the second for high level and the third for very high level, along with necessary junction box, local control panel, control cables etc. to achieve automatic starting/stopping of the sump pumps, and also ON/OFF indication for sump pump shall be monitored at DCS. The entire assembly being mounted on the same base frame as mentioned above (item "b"). The control panel shall also be equipped with start/stop push button for starting/stopping individual sump pumps manually. Local control panel and cable shall be as per Volume-IV A&B of the specification. 4.3 For each of the trolley mounted horizontal Group-B sump pump motor sets 4.3.1 One (1) 7.5 meters long hose for the pump suction and one (1) 30 meters long hose for the pump discharge, either ends of each hose being provided with female hose coupling. 4.3.2 One (1) 500 mm long straight pipe piece, with both ends flanged, one end matching with the pump suction nozzle.		

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4.3.3 4.3.4 4.3.5 4.3.6 4.4 4.4.1 4.4.2 4.4.3	Two (2) male type hose couplings, one of which is suitable for coupling with the above mentioned 500 mm pipe piece on one side and the 7.5 meters long suction hose on the other side, whereas the other is suitable for coupling with the pump discharge nozzle on one side and the 30 metres long hose on the other side. The pump suction pipe piece and discharge nozzle shall be of flanged type. As such each coupling end that is to match with the pipe/pump nozzle shall also be flanged and shall be equipped with necessary bolts, nuts & gaskets. A foot valve (of Bidder's recommended size) with suction strainer, necessary coupling and matching piece/reducer (if necessary) to couple with the 7.5 meter long suction hose end. A starter panel complete with incoming switch/contacter fuse, overload relays, start-stop push button, O/L reset push button, cable gland, wiring terminals, red and green indication lamps (LED type), necessary control cables etc and also 50 metres length of flexible power cable with power plug at one end and arrangement to connect the other end with the starter panel. The pump motor set with a base frame along with the starter panel, power cable, suction & discharge hoses etc., as mentioned above, shall be mounted on a suitable trolley with swivelling front wheel and having adequate fixing arrangement for all equipment, for operation without any undue vibration and with facility for being handled by a single operator. For each of the portable submersible Group-C sump pump motor sets. One (1) 30 metres long discharge hose, having female hose coupling at both ends. One (1) 500 mm long pipe piece with both ends flanged, one end connected by necessary bolts, nuts & gaskets with the flanged discharge nozzle of the sump pump. One (1) male type hose coupling, one end of which is suitable to couple with the discharge hose and the other end is flanged, matching with the above mentioned 500 mm long pipe end and connected therewith by necessary bolts, nuts & gaskets.	

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4.4.4	Suitable attachment for temporary seat of the pump motor set on the floor at sump bottom.	
4.4.5	One (1) 25 metres long submersible type power cable having a power plug at one end and a hermetically sealed (water proof) cable gland for connection with the pump drive- motor at the other end.	
4.4.6	Suitable lugs and other attachments on the pump motor assembly frame, for hoisting and lowering of the pump motor set from and to the sump.	
4.4.7	One starter panel, having a plug socket as receptacle of the above mentioned power plug (item "e"), a 25 metre long incoming power cable with switch/contacter and fuse, start- stop push buttons, red and green LED type indication lamps, over load relays, O/L reset push button, cable gland etc., and also a suitable arrangement for temporarily mounting the starter panel, near the sump, where the portable sump pump-motor set is to work. The incoming 25 metre long power cable shall also be provided with a suitable power plug at one end.	
4.5	For the vertical Group - D sump pump motor sets, the scope of supply shall be similar to Group - A sump pump motor sets, except that the discharge piping from pump nozzles shall be taken up to the following areas :	
4.5.1	For ESP Control Room Building, the sump pump discharge shall be taken to Ash Slurry Sump.	
4.5.2	For AHP Control Building, the sump pump discharge shall be taken to Ash Slurry Sump.	
4.5.3	For the Ash slurry pump house sump pump and HCSD pump house sump pump, discharge shall be taken to the ash slurry sump.	
4.6	Other accessories to be supplied with the pump-motor sets are as follows:	
4.6.1	One discharge pressure gauge with 3 way SS isolating valve for each pump of Group-A and Group-D and all other instrumentation as required for safe and trouble free operation.	
4.6.2	Suction and discharge pressure gauge for Group-B pump.	

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4.6.3	All integral/internal piping, valves, fittings etc. for lubrication, cooling and sealing for each pump, wherever required.	
4.6.4	All equipment, accessories and consumable required for erection, testing and commissioning.	
4.7	Lubrication of one (1) initial fill and one additional fill after commissioning.	
4.8	Rust inhibitor paint at Manufacturer's works.	
4.9	Any additional accessories not mentioned hereinabove but specified in enclosed technical specification for sump pumps, as applicable and those indicated in sump pump data specification sheets and electric motor specification should also be supplied.	
5.0	<u>DESIGN AND CONSTRUCTION</u>	
5.1	The design, construction testing and other details of the sump pumps and related accessories shall be in line with the stipulations and data in this section and the Master Specification (Volume II).	
5.2	Each sump pump shall be equipped and coupled with a drive motor, with rating so selected as to have at least 15% margin over the maximum power required by the pump, throughout its range of operation. All other requirements of the drive motors shall be as stipulated in the Volume IV-A/B. The discharge rate of sump pump is uncontrolled. As such pump should be capable to operate even under a condition of as low as 25% of specified total head. Motors of group-B pumps should be designed to cater such eventuality.	
5.3	All electrical items shall conform to the stipulations of electrical section.	
5.4	All piping shall be as per IS-1239 of medium or heavy grade (as suited for the maximum operating pressure) and shall be either galvanised or painted with approved rust inhibiting paint. Pipe size shall be as per Datasheet -A. Any matching piece/reducer required to match the pipe with pump nozzle, hose, etc. shall be provided.	

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5.5	All valves shall be steel body type as per applicable IS/BS/ANSI standards, with pressure class compatible with the maximum working pressure.	
5.6	All hoses shall be of steel wire reinforced type. Pump suction hose shall be suitable for working under vacuum. Pump discharge hose shall be suitable to withstand the maximum pressure that it may be subjected to in all working conditions, including hydrostatic testing of the sump pump discharge line.	
5.7	Pump suction strainer shall have openings large enough just to permit the entry of solids having maximum size as stipulated.	
5.8	Pressure gauges shall be of Bourdon type, with sealing diaphragm to prevent ingress of the working fluid. Selected range of pressure gauge shall be such that the entire range of working pressure covers about 1/3rd to 2/3rd to its range. Accuracy of measurement shall be within $\pm 1\%$ of scale range. The suction pressure gauge shall be compound type. Pressure gauge dial size shall be 100 mm or more.	
5.9	<u>PUMPS</u>	
5.9.1	Pumps under Group-A shall be wet pit type, vertical shaft, centrifugal, vertical submerged suction, non-clog volute type complete with enclosed shaft, discharge pipe, head assembly thrust bearing and drive assembly, cover plates etc.	
5.9.2	Pumps under Group-B shall be of horizontal shaft, single stage, end suction, radially split casing, centrifugal, non-clog design complete with common base plate, drive assembly etc. These pumps shall be trolley mounted portable type.	
5.9.3	Pumps under Group-C shall be submersible pump-motor type, single stage and non-clog design and shall be portable type.	
5.9.4	Pumps under Group-D shall be similar to Group-A pumps.	

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5.9.5 Casing (a) Casing shall be so designed to allow free passage of specified maximum size of solid. (b) Casing shall be designed to withstand the maximum shut-off pressure developed by the pump. (c) The casings shall be cast, free from blow holes, sand holes, and other detrimental defects. The casing shall be complete with suction and discharge connections. (d) For pumps under Group-A, and Group-D adequate seal arrangement shall be made to keep leakage of liquid from casing to column assembly to minimum and adequate drain shall be provided in column assembly to permit escape of the leakage flow. The casing shall also include the bearing housing of the bottom pump shaft bearing. (e) Casing of pumps under Group-B shall be provided with vent connections and drain connections with valves. These pumps shall be manually primed. 5.9.6 Impeller (a) The impeller shall be open/semi-open non clog type, cast in one piece and specially designed to pass large solids or unscreened liquids. The clearance between stationary and moving parts should be such as to allow sustained performance without exclusive maintenance. (b) Impellers of pumps under Group-A and Group-D shall have provision for adjustment from an accessible location and for pumps under Group-C shall be capable of passing fibrous material like cotton waste, jutes, etc.		

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5.9.7 Pump Shaft (a) Shaft size selected shall be such that critical speed is at least 20% away from the operating speed and the runway speed. (b) The shaft shall be ground and polished to final dimension and of ample size to withstand all stresses resulting from rotor weight, hydraulic loads and across the line starting. Shaft shall be provided with renewable sleeves particularly under stuffing boxes and other locations as recommended by pump manufacturers. (c) The coupling between shafts shall be so designed that they become tight during pump operation. 5.9.8 Column Pipe (for pumps under Group-A and Group D) The discharge pipe shaft assembly shall be flanged or screwed as per manufacturer's standard and standard length of each piece of column pipe shall be in conformity to the shaft piece lengths from consideration of easy handling. 5.9.9 Bearings (a) Adequate nos. of properly designed bearings shall be furnished. Bearings for pumps shall be antifriction type and lubricated by grease. Line shaft bearings of vertical pumps shall also be grease lubricated. All necessary grease gun, grease cup and tubing shall be included. (b) Thrust bearing of adequate design shall be furnished for taking the entire pump thrust arising from all probable conditions of continuous operation through out its "range of operation" and also the shut-off condition. The life of thrust bearing shall be 20,000 working hours minimum for the load corresponding to the duty point. The bearings shall be lubricated by grease from a location conveniently accessible. Design shall be such that the lubricant can not contaminate the handling liquid.		

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5.9.10	Wearing Ring/Liner Plate Renewable wearing rings/liner plates shall be provided either on impeller or on the casing or on both impeller and casing.	
5.9.11	Stuffing Box Stuffing Box of pumps under Group-A and Group-D shall be of mechanical packing type. For pumps under Group-B and Group-C mechanical seal of reliable design shall be provided.	
5.9.12	Coupling Pump and motor shall be connected with a suitable flexible coupling. Coupling shall be provided with coupling guard.	
5.9.13	Mounting Plate for Group-A and Group-D Pumps and Base Plate for pumps under Group-B. Each pump under Group-A and Group-D shall be provided with a suitable mounting plate. The mounting plate shall be adequately sized to accommodate the level switches, discharge pipe, grease cups etc, if any. Pumps and motor under Group-B shall be mounted in one base plate. Base plate shall be of rigid construction properly ribbed as needed. Suitable drain with valve and drain funnel shall be furnished by the Bidder. The necessary supporting plate, mounting frame, base plate etc. as required shall be supplied under this specification, along with anchor bolts, foundation bolts, pipe, sleeves etc. Lifting lug, eye bolts, etc. as required for the proper handling of each pump set shall be furnished.	
5.9.14	Suction Bell The pumps under Group-A, C and D shall be complete with adequately dimensioned suction bell to guide and streamline intake fluid.	

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5.9.15 Material of Construction For material of construction of various parts, Datasheet - A shall be referred to.		

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<u>ANNEXURE- I</u> <u>SCHEDULE OF SUMP PUMPS</u> <u>GROUP-A PUMPS : PERMANENTLY INSTALLED VERTICAL SUMP PUMP</u>							
Sr. No	Location	Numbers required (Total)	Capacity (m ³ /Hr) Each	Total head (MLC)	Pit size in which pumps are to be installed (in mm)	Type of liquid to be handled	Remarks
1.0	These pumps should be located in the following areas as minimum :	Two pumps (100% capacity) are to be located in each sump pit	Capacity of each pump shall be so selected to empty the sump pit in 10 to 15 minutes	To be calculated with 10% margin over total dynamic head (TDH = static head + friction losses)	To be decided by the bidder	As described	Discharge pipe sizing shall be done taking minimum water velocity to be 2 m/sec but shall not be less than 50 NB. One gate valve and one non-return valve shall be provided at pump discharge.

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Sr. No	Location	Numbers required (Total)	Capacity (m ³ /Hr) Each	Total head (MLC)	Pit size in which pumps are to be installed (in mm)	Type of liquid to be handled	Remarks
	(a) Power house ground floor sump pits near condenser						
	(b) Underground conveyor tunnel in mill reject system						
	(c) Drain oil pit in transformer yard						
	(d) Any other places felt necessary by Bidder.						
2.0	These pumps shall also be provided in						

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Sr. No	Location	Numbers required (Total)	Capacity (m ³ /Hr) Each	Total head (MLC)	Pit size in which pumps are to be installed (in mm)	Type of liquid to be handled	Remarks
	all indoor sumps and outdoor sumps of capacity 5 m ³ & above and underground cable vaults (if any).						

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<u>GROUP-B PUMPS : HORIZONTAL CENTRIFUGAL TROLLEY MOUNTED PORTABLE SUMP PUMP</u>							
Sr. No.	Location	Numbers required (Total)	Capacity (m ³ /Hr) Each	Total head (MLC)	Pit size in which pumps are to be installed (in mm)	Type of liquid to be handled	Remarks
	Pumps will be used in various sumps of the plant area like fuel oil transferring pump house and fuel oil pressurising pump house.	Three (3)	Ten (10) (Working Range: 0 to 125%)	Six (6) To be finalised by the Bidder	To be finalised by the Bidder	As mentioned	To supply with suction & discharge pressure gauge and other accessories as specified and shall be trolley mounted. Suction hose should be of 80 NB size. Discharge hose should be of 65 NB size.

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<u>GROUP-C PUMPS : VERTICAL SUBMERSIBLE PORTABLE SUMP PUMP</u>							
Sr. No	Location	Numbers required (Total)	Capacity (cum/Hr.) Each	Total head (MLC)	Pit size in which pumps are to be installed (in mm)	Type of liquid to be handled	Remarks
1.0	Pumps will be used in various deep sumps / pits (e.g. Clarified water pump house, Raw water pump house, CW pump house) in case of eventuality.	Four (4)	100 (Working range as per pump characteristic curve for full range of head variation).	Twenty (20) (Range 5 to 25)	To be finalised by the Bidder	As mentioned	To be supplied with discharge pressure gauge and 500 mm M.S. pipe spool at discharge as specified Discharge hose should be of 100 NB size.

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<u>GROUP-D PUMPS : PERMANENTLY INSTALLED VERTICAL SUMP PUMP</u>							
Sr. No.	Location	Numbers required (Total)	Capacity (cum/Hr.) Each	Total head (MLC)	Pit size in which pumps are to be installed (in mm)	Type of liquid to be handled	Remarks
1.0	These pumps should be located in the following areas as minimum :	Two pumps (100% capacity) are to be located in each sump pit	Capacity of each pump should be so selected to empty the sump pit in 10 to 15 minutes	To be calculated with 10% margin over total dynamic head (TDH = static head + friction losses)	To be decided by the Bidder	As described	Discharge pipe sizing should do taking minimum water velocity to be 2 m/sec but should not be less than 80 NB. One gate valve and one non-return valve should provide at pump discharge.
	(a) ESP control Building						
	(b) AHP Control Building						
	(c) Ash slurry pump house						
	(d) Any other places felt						

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Sr. No.	Location	Numbers required (Total)	Capacity (cum/Hr.) Each	Total head (MLC)	Pit size in which pumps are to be installed (in mm)	Type of liquid to be handled	Remarks
	necessary by the Bidder.						
	(e) These pumps will also be provided in all indoor sumps and outdoor sumps of capacity 5 m ³ and above						

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VOLUME III-I
SECTION-3/B
HORIZONTAL SERVICE WATER PUMPS

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1.0 <u>GENERAL INFORMATION</u> 1.1 This section presents the general guidelines and details of construction of horizontal water service pumps to be provided under the scope Package. If bidder proposes to install any other additional horizontal water service pumps in the scope of Plant Water System Package, the general guidelines as specified hereinafter shall be strictly adhered to by the Bidder. 2.0 <u>CODES AND STANDARDS</u> 2.1 The design, manufacture and performance of the horizontal centrifugal pumps as specified hereinafter, shall comply with the requirements of the following codes and standards and shall include all its latest amendments subsequent to the year of publication as mentioned below. In addition, to the following codes and standards, other applicable codes of practice as mentioned in Volume: II of this specification shall also be applicable. <table border="0"> <tr> <td>2.1.1</td><td>IS-6595 Part-2</td><td>: Horizontal Centrifugal pumps for clear, cold and fresh Part-2 water (General purpose).</td></tr> <tr> <td>2.1.2</td><td>IS-5120</td><td>: Technical requirements for Roto dynamic special Purpose pumps.</td></tr> <tr> <td>2.1.3</td><td>IS-5639</td><td>: Pumps for handling chemicals & corrosive liquids.</td></tr> <tr> <td>2.1.4</td><td>IS-5659</td><td>: Pumps for process water</td></tr> <tr> <td>2.1.5</td><td>IS-6536</td><td>: Pumps for handling volatile liquids.</td></tr> <tr> <td>2.1.6</td><td>IS-9137</td><td>: Code for acceptance tests for centrifugal, mixed flow and axial flow pumps - Class "C".</td></tr> <tr> <td>2.1.7</td><td>BS EN ISO : Flow 9906 : 2000</td><td>: Acceptance tests for centrifugal, mixed flow and axial pumps - Class "B" tests.</td></tr> </table>			2.1.1	IS-6595 Part-2	: Horizontal Centrifugal pumps for clear, cold and fresh Part-2 water (General purpose).	2.1.2	IS-5120	: Technical requirements for Roto dynamic special Purpose pumps.	2.1.3	IS-5639	: Pumps for handling chemicals & corrosive liquids.	2.1.4	IS-5659	: Pumps for process water	2.1.5	IS-6536	: Pumps for handling volatile liquids.	2.1.6	IS-9137	: Code for acceptance tests for centrifugal, mixed flow and axial flow pumps - Class "C".	2.1.7	BS EN ISO : Flow 9906 : 2000	: Acceptance tests for centrifugal, mixed flow and axial pumps - Class "B" tests.
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2.1.8	BS EN ISO Flow 9906 : 2000	: Acceptance tests for centrifugal, mixed flow and axial pumps - Class "C" tests
2.1.9	API-610	: Centrifugal pumps for general refinery services.
2.1.10	Standards of the Hydraulic Institute of USA (1983).	
2.1.11	PTC 8.2	: Power Test Codes - Centrifugal pumps.
2.1.12	Other accepted International Standards such as DIN/JIS/GOST etc which may be equivalent or superior to those specified above.	
2.2	In case of any contradiction between the above standards and this section with its annexure, the stipulations in this section and annexure shall prevail and shall be binding to the Contractor.	
3.0	<u>SCOPE OF WORKS</u>	
3.1	<u>SCOPE OF SUPPLY</u>	
3.1.1	The scope of supply under this section shall be as below. Items not specifically mentioned but deemed necessary by the Bidder for making the system completely reliable and efficient shall also be included.	
(a)	Equipment	
	Two (2) DM water transfer pumps complete with electric motor drives and all other accessories as specified in this section and in the annexures attached herewith.	
	Any other Horizontal Centrifugal pumps complete with electric motor drives and all other accessories, if included by the Bidder within the scope of package.	

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(b) Equipment Accessories Each pump set for all above groups shall be supplied with the following accessories: (i) Couplings of approved design to connect pump shaft directly with the motor shaft. (ii) Sets of base plates, support plates, grounding pads, lifting lugs, eye bolts, nuts etc for each pump and motor set. (iii) Slip-on type drilled steel counter flanges of proper rating for both suction and discharge connections of each pump set. All the counter flanges shall be complete with requisite number of bolts, nuts, gaskets etc. (iv) Air release cocks and drain plugs for each pump set. (v) Discharge line pressure gauge and suction line pressure/ vacuum gauges complete with isolating cocks for each pump set. (vi) All internal/integral piping with valves, fittings, and pressure gauges for lubrication, cooling and sealing, wherever applicable, shall be tapped of directly from respective pump discharge. 3.2 For details regarding scope of services and works, Volume-II of this specification shall be referred to. 4.0 <u>PERFORMANCE REQUIREMENTS</u> 4.1 Performance requirements for all the pumps shall be as guided in the Datasheet-A enclosed with this section. 4.2 Pumps shall preferably be designed to have the best efficiency at the specified duty point. The pumps shall be suitable for continuous operation at any point within the "Range of Operation" as stipulated in the annexures attached with this section.		

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4.3	Pumps shall preferably have a continuously rising head-capacity characteristics from the specified duty point towards shut-off point, the maximum being at shut-off to enable parallel operation. Under all circumstances, the "range of operation" of the pumps shall exclude any unstable operating zone of the head - capacity curve.	
4.4	Wherever specified in the annexures attached herewith, pumps of each category shall be suitable for parallel operation. The head vs capacity, the BHP vs capacity characteristics etc shall be identical to ensure equal load sharing and trouble-free operation of any pump when the other pump(s) working in parallel with it trip.	
4.5	The pump set along with the drive motor shall run smooth without undue noise and vibration. Acceptable peak to peak vibration limits shall be generally guided by the Hydraulic Institute Standards of USA.	
5.0	<u>DESIGN AND CONSTRUCTION</u>	
5.1	<u>PUMP CASING</u>	
5.1.1	Pump casing shall be provided with adequate number of vents and priming connections with valves unless the pump is made self- venting and priming. Casing drain, as required, shall be provided complete with drain valves.	
5.1.2	Pump design must ensure that the nozzles are capable of withstanding external reactions not less than those specified in API-610.	
5.1.3	In cases where an expansion joint is located at pump discharge, the pump assembly shall be subjected to an additional thrust which shall be transmitted to the foundation. This additional thrust shall be taken into consideration during pump design.	
5.2	<u>IMPELLER</u>	
	The rotor assembly shall be dynamically balanced and designed with critical speed substantially above the operating speed.	

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5.3 <u>WEARING RINGS</u> Replaceable type wearing rings shall be furnished to prevent damage to impeller and casing. 5.4 <u>SHAFT</u> Shaft size shall be selected considering that the critical speed shall be away from the operating speed as recommended in applicable Code/Standard. The critical speed shall also be at least 10% away from runaway speed. 5.5 <u>SHAFT SLEEVES</u> 5.5.1 Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the other faces of gland packing or seal end plate so as to distinguish between the leakage past shaft and shaft sleeve and that past the seals / glands. 5.5.2 Shaft sleeves shall be properly fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly shall ensure concentric rotation. 5.6 <u>BEARINGS</u> 5.6.1 Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearing housing. 5.6.2 Heavy duty sleeve/ball/roller type bearings shall be provided to take care of the radial loads. 5.6.3 In case of sleeve type radial bearings, axial thrust shall be absorbed in suitable hydraulic devices and/or thrust bearings. 5.6.4 Bearings and hydraulic devices (if provided for balancing axial thrust) shall be of adequate design for taking the entire pump load arising from all probable conditions of continuous operation. Life of the bearings shall be guided by the design standard of the pump. Thrust bearing shall be capable of running continuously at maximum load.		

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5.6.5	The bearings shall be oil/grease lubricated. Suitable lubricating arrangement for the bearings shall be furnished with the pump complete with all accessories like pump filters, piping, fittings, valves, interlocking and supervising instruments etc as necessary. The design shall be such that the bearing lubricant does not contaminate the liquid being pumped.	
5.7	<u>STUFFING BOXES</u>	
5.7.1	Stuffing box design shall permit replacement of packing without removing any part other than the gland.	
5.7.2	Stuffing boxes shall be sealed / cooled by the fluid being pumped. All necessary pumps, piping, fittings, valves, instruments etc as required for safe and trouble-free operation of the pumps shall be included in the scope of supply.	
5.8	<u>MECHANICAL SEALS</u>	
5.8.1	Mechanical seals shall be provided if specified in the Datasheet-A attached with this section. The pump supplier shall co-ordinate with the seal maker in establishing the circulation rate for maintaining a stable film at the seal face in the chamber. The seal piping system shall form an integral part of the pump assembly.	
5.8.2	For the seals under vacuum service, the seal design must ensure sealing against atmospheric pressure, even when the pumps are not operating.	
5.9	<u>DRIVE UNIT</u>	
5.9.1	The pumps shall be driven by electric motor directly coupled. A heavy duty flexible coupling along with coupling guard shall be provided between the pump and drive unit. For details regarding specification of drive unit Volume-IV-A&B of this specification shall be referred.	
5.9.2	Unless otherwise specified, drive unit power rating shall be maximum of the following requirements. (a) 15% margin over the pump shaft input power at the rated duty point.	

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(b) 5% margin over the maximum pump shaft input power required within the "Range of Operation". (c) Pump shaft input power required considering the overloading of the pump assuming single pump operation in the event of tripping of one or more of the pumps operating in parallel.		

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1.0	<u>GENERAL INFORMATION</u>
1.1	This section presents the general guidelines and details of construction of vertical water service pumps to be provided under the scope. If Bidder proposes to install any other additional vertical water service pumps, the general guidelines as specified in the subsequent clauses of this section shall be strictly adhered to by the Bidder.
2.0	<u>CODES AND STANDARDS</u>
2.1	In addition to the requirements spelt out in Volume-II of this specification, the equipment to be provided under this section shall specifically conform to the following codes, standards, specifications and regulations, as applicable, including all the latest amendments as mentioned below.
2.1.1	IS-1710 : Vertical Turbine Pumps for Clear, Cold and Fresh Water.
2.1.2	IS-5120 : Technical requirements – Roto-dynamic special purpose pumps.
2.1.3	IS-5639 : Pumps for handling chemicals and corrosive liquids.
2.1.4	IS-5659 : Pumps for process water
2.1.5	IS-6536 : Pumps handling volatile liquids.
2.1.6	IS-9137 : Code for acceptance for centrifugal, mixed flow and axial flow pumps - Class 'C'.
2.1.7	BS EN ISO 9906 : 2000 : Acceptance tests for Centrifugal, mixed flow and axial flow pumps - Class 'C' Tests.
2.1.8	BS EN ISO 9906 : 2000 : Acceptance tests for Centrifugal, mixed flow and axial flow pumps - Class 'B' Tests.
2.1.9	ANSI B 73.2 M : Vertical inline centrifugal pumps for chemical process.
2.1.10	API 610 : Centrifugal pumps for general refinery services

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2.1.11	Hydraulic Institute Standards of USA	
2.1.12	PTC 8.2 : Power Test Codes - Centrifugal pumps.	
2.1.13	Other accepted International Standards such as DIN/JIS/GOST etc which may be equivalent or superior to those specified above.	
2.2	In case of any contradiction between the above standards and this section and Datasheet-A attached to this section, the stipulations in the aforesaid section and Datasheet-A shall prevail and shall be binding on the Contractor.	
3.0	<u>SCOPE OF WORK</u>	
3.1	<u>SCOPE OF SUPPLY</u>	
3.1.1	The scope of supply under this section shall be as grouped and specified in Datasheet-A enclosed with this section. Items not specifically mentioned but deemed necessary by the Bidder for making the system completely reliable and efficient shall also be included.	
3.2	Three (3) Raw water supply pumps located in Raw water supply pump house for supplying water to cascade aerator common for both DM and Non DM complete with electric motor drives and all other accessories as specified in this section and in the datasheet-A attached herewith.	
3.3	Two (2) Ash water supply pumps located in Raw water supply pump house for supplying water to Ash Handling System makeup complete with electric motor drives and all other accessories as specified in this section and in the datasheet-A attached herewith.	
3.4	Two (2) Potable water supply pumps for plant water supply located in Filtered Water pump house for Non-DM complete with electric motor drives and all other accessories as specified in this section and in the datasheet-A attached herewith.	
3.5	Two (2) Potable water supply pumps for colony water supply located in Filtered Water pump house for Non-DM complete with electric motor	

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drives and all other accessories as specified in this section and in the datasheet-A attached herewith. 3.6 Two (2) Service water pumps for plant cleaning and washing located in Filtered Water pump house for Non-DM complete with electric motor drives and all other accessories as specified in this section and in the datasheet-A attached herewith. 3.7 Three (3) Cooling Tower make up pumps located in Filtered Water pump house for Non-DM complete with electric motor drives and all other accessories as specified in this section and in the datasheet-A attached herewith. 3.8 Two (2) Emergency make-up supply pumps located in Filtered Water pump house for Non-DM complete with electric motor drives and all other accessories as specified in this section and in the datasheet-A attached herewith. Three (3) Clear water Transfer pumps for AHP/Coal Handling Plant DS/Service water/ Horticulture supply located in Effluent Water pump house complete with electric motor drives and all other accessories as specified in this section and in the annexure attached herewith Each pump set for all the above groups shall be supplied with the following accessories, as applicable. (a) Heavy duty couplings of approved design to connect the pump shaft directly with the motor shaft. (b) Sets of base plates, support plates, grounding pads, thrust blocks, lifting lugs, eye bolts, nuts etc for each pump and motor set. (c) Slip on type drilled steel counter flanges of proper rating to suit the discharge flange of each pump set. All the counter flanges shall be complete with requisite number of bolts, nuts and gaskets etc. (d) Thrust pads, if required, for pump discharge head complete with all necessary fixing and bolting arrangement, fasteners etc.		

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(e) One (1) pressure indicator with isolating cocks at the discharge side of each pump, two (2) additional stubs with isolating root valves for pressure tapings and two (2) thermowells for temperature tapings at the discharge side of each pump for performance testing. Thrust bearing shall be furnished with dial type thermometer, temperature switch for high temperature annunciation and oil level gauge. (f) All internal/integral piping with valves, fittings and instruments for lubrication, cooling and sealing, if applicable, shall be tapped off from respective pump discharge. (g) Pump of higher capacity using 3.3 KV drives motor shall be equipped with vibration measuring and temperature measuring probes for pump and motor bearing with adequate annunciation / interlock function. 3.9 For detailed scope of services and works, Volume-II of this specification shall be referred to. 4.0 <u>PERFORMANCE REQUIREMENTS</u> 4.1 Performance requirements for all the pump(s) shall be as specified in datasheet-A enclosed with this section. 4.2 Pump(s) shall preferably be designed to have the best efficiency at the specified duty point. Further, the pump(s) shall be suitable for continuous operation at any point within it's 'range of operation' as specified in datasheet-A enclosed with this section. 4.3 Pump(s) shall preferably have continuously rising head-capacity characteristics, with maximum head at pump discharge shut-off, to enable parallel operation Under all circumstances, the 'range of operation' of the pump(s) shall exclude any unstable operating zone of the head-capacity curve. 4.4 In case the datasheet-A call for parallel operation of the pumps, pumps shall have identical characteristics to ensure equal load sharing and shall		

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ensure trouble-free operation of any pump when the other pump(s) working in parallel with it trip.		
5.0	<u>DESIGN AND CONSTRUCTION</u>	
Pumps shall be of vertical shaft, complete with bowl, column pipe, discharge head and base plate with all accessories, as applicable. General design and constructional features of the pumps shall be as follows:		
5.1	<u>BOWL ASSEMBLY</u>	
5.1.1	This shall be either a single or multi-stage centrifugal, mixed flow or axial flow type with discharge co-axial with shaft. Type of impeller shall be chosen on the basis of the pump specific speed and the characteristics of the handling fluid.	
5.1.2	Pump(s) shall have provision for adjustment of impellers in vertical direction from an accessible location, preferably at the housing (where separate thrust bearing for the pump is provided). The adjustment mechanism must take into consideration the extension of the line shaft due to hydraulic down thrust, weight of the shaft and impeller.	
5.2	<u>DISCHARGE HEAD</u>	
5.2.1	Pump(s) shall be either above floor or below floor discharge type, as specified in the annexures, attached to this section.	
5.2.2	In case, expansion joint is to be used at the pump discharge, pump base plate shall either be adequately designed to take the unbalanced forces and moments from the use of such expansion joint or a separate thrust block at the pump discharge head shall be provided to transmit these forces to the external supporting structure. Calculation of thrust load shall be done considering the highest pressure seen by the pump and internal diameter of the arch of the expansion bellow.	

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5.3	<u>COLUMN PIPE</u>	
5.3.1	Column pipe shall be flanged and of bolted connection. Column pipes shall be designed for full internal vacuum.	
5.3.2	In case the datasheet-A ask for the pump with below floor discharge, and the water level is at or above the discharge valve level, the column pipe piece located at the intermediate floor level shall be provided with suitable floor sealing device.	
5.3.3	In case of multi-piece column pipe and shaft assembly, the design shall permit raising/lowering of the pump assembly piece by piece without any difficulty. Any fixtures, clamps etc necessary for such purpose shall be supplied by the Contractor. The Contractor shall also submit a write-up describing clearly the procedure of handling the pump.	
5.4	<u>IMPELLER SHAFT, LINE SHAFT AND HEAD SHAFT</u>	
5.4.1	Shaft size shall be selected on the basis of maximum torque to be applied on the pump shaft. Critical speed of the shaft shall be sufficiently away from the pump operating speed and in no case shall lie between 90% and 110% of the rated speed.	
5.4.2	Impeller shaft shall be guided by bearings provided in each bowl or above and below the impeller shaft assembly. The butting faces of the shaft shall be machined square to the assembly and the shaft shall be chamfered at the edges.	
5.4.3	Line shaft may be of single or multiple pieces as required. In case of multiple pieces, line shaft shall be coupled as per the standard practice of the manufacturer. For screwed coupling, screw directions shall permit tightening of the joint during pump operation.	

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5.4.4	Replaceable shaft sleeves shall be furnished at applicable locations, particularly under stuffing box and at other locations, as considered necessary.	
5.5	<u>SHAFT ENCLOSING TUBE</u> Shaft enclosing tube shall be required, unless self lubricated (and cooled) type of shaft bearings are asked for. Length of the shaft enclosing tube shall be in conformity with the shaft piece lengths.	
5.6	<u>SEAL RINGS</u> Replaceable seal/wear rings both on impeller and on casing shall be provided.	
5.7	<u>BEARINGS</u>	
5.7.1	Shaft Bearings Adequate number of properly designed bearings shall be provided for smooth and trouble-free operation of the pump. Number of bearings shall consider the number of shaft pieces used and the critical speed of the shaft. Bearings shall be either lubricated by external clear water/oil/grease or self lubricated as specified in the datasheet-A. In case of external water/oil lubrication, complete lubrication arrangement shall be furnished with the pump. Pre-lubrication tank and other accessories shall be within the scope of supply of the Bidder/Contractor, if required.	
5.7.2	Thrust Bearing Location of the thrust bearing may be at the pump body or at the driver or at both depending on the requirement of datasheet-A or as per the recommendation of the pump manufacturer (and approved by Owner). Thrust bearings shall be either grease or oil lubricated. Lubrication arrangement shall be such that the lubricant does not contaminate the handling fluid. The arrangement shall also be adequate to protect the	

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bearing, while the pump coast down to stop in case of power failure of the station. Pre-lubrication of the thrust bearing, if recommended by the pump manufacturer, shall be taken care of in designing the lubrication system.

Cooling of the thrust bearing, if necessary, shall be done by the handling fluid/external water, depending on the fluid handled.

Location of the thrust bearing may be at the pump body or at the driver, or at both depending on the requirement of datasheet-A or as per the recommendation of the pump manufacturer (and approved by Owner).

5.8 REVERSE ROTATION

5.8.1 The pump impeller and other rotating components shall be designed for reverse rotation, when subject to reverse flow at rated pump discharge head.

5.9 DRIVE UNIT

5.9.1 The pump shall be driven by electric motor.

A heavy duty coupling shall be provided between the drive unit and the driven equipment (except for belt drive).

5.9.2 Unless otherwise specified, drive element power rating shall be the maximum of the following requirements.

- (a) 15% margin over the pump shaft input power at the rated working condition.
- (b) 5% margin over the maximum pump shaft input power required within its operating range including the shut off point.
- (c) Pump shaft input power required considering overloading of the pump assuming single pump operation in the event of tripping of the other pump(s) operating in parallel.

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5.9.3 The drive equipment shall preferably be air cooled. In case the pumping fluid is water, free of abrasive and corrosive matter, the same can be used for cooling purpose.		

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1.0	<u>GENERAL INFORMATION</u>	
	This section covers the design, supply of miscellaneous steel storage and all accessories as required, paints and protective paintings as specified and as required, fabrication, erection, painting, testing and associated civil works.	
2.0	<u>CODES AND STANDARDS</u>	
2.1	Steel Storage Tanks	
	The design, manufacture and testing of tanks shall comply with the requirements of one or more of the following standards as applicable	
2.1.1	IS-805 : Code of practice for use of steel in gravity water tank.	
2.1.2	IS-803 : Code of practice for use of Vertical Storage Tank.	
2.1.3	IS-816 : Code of practice for use of metal arc welding for general construction in mild steel.	
2.1.4	IS-9595 : Code of procedure for manual metal arc welding of mild steel.	
2.1.5	BS EN 12285-1 : 2003 : Carbon steel welded horizontal cylindrical tank	
	BS EN 12285-2 : 2005	
2.1.6	IS-10987 : Horizontal Cylindrical storage tank for Petroleum products.	
3.0	<u>SCOPE OF WORK</u>	
3.1	The details of Miscellaneous steel tanks (minimum) for storage of water at atmospheric pressure to be fabricated and erected under this section of specification are given as follows:	
3.1.1	Two (2) Potable water Tanks shall be installed on the roof of Deaerator Floor.	
3.1.2	Two (2) Service water tanks shall be located on the roof of Deaerator Floor.	
3.1.3	Two (2) DM water storage tanks shall be located in the vicinity of DM plant.	

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3.1.4 One (1) Condensate Storage Tank near Compressor House 3.1.5 Two (2) De-Mineralized Circulating Water Storage tanks (One common for SG & TG Auxiliaries shall be installed on the Auxiliaries PRDS floor & One for Ash Handling Plant on AHP Air compressor room.) 3.2 The connections, accessories and fittings to be supplied with each tank shall be as specified and as required. Tank connections shall be provided with suitable counter flanges with necessary bolts, nuts & gaskets. 3.3 The tank, where applicable, shall be complete with supporting structure, legs or pedestals, base plate, anchor bolts, nuts & sleeves etc, as required. 3.4 The special fittings e.g. conservation vent valves, level indicators etc shall also be supplied by the Contractor. 3.5 Preparation of detailed design, fabrication drawings, bill of materials, tag and piece numbers, welding procedure etc. Stiffeners where not specified and other structural framing for supporting tank shell shall be designed by the Contractor including supply of materials for the same. 3.6 This specification covers supply of steel plates, structural steel, pipes etc, as required. 3.7 The scope of work under this specification includes excavation and backfilling work required for installation of pipes running underground. 3.8 All pipe supports, thrust blocks, etc. as required shall be properly designed and constructed by the Contractor in accordance with approved drawings. Necessary steel work at supports shall also be supplied, fabricated and erected by the Contractor. 3.9 The final fixing grout over the concrete support or through the opening left in the concrete work shall also be done by the Contractor. 4.0 <u>DESIGN AND CONSTRUCTION</u> 4.1 Tanks shall be suitably constructed for safe, proper and continuous storage of liquid described. The design code, material standard, minimum plate		

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thickness, size and other details shall be as per the specified Codes and Standards, as applicable. 4.2 For cylindrical tanks, the plates shall be cold rolled through plate bending machine by several number of passes to true curvature. 4.3 Vessel seams shall be so positioned that they do not pass through vessel connections. For cylindrical vessels consisting of more than two sections, longitudinal seams shall be offset. 4.4 Where possible, the inside seam weld shall be ground smooth, suitable for application of corrosion resistant primer. 4.5 Due consideration for wind load and/or earthquake effect shall be given in the design of tanks. Data for wind load and earthquake shall be taken as indicated in the Volume-II of this specification. Maximum allowable stresses for design loadings combined with wind or earthquake shall not exceed 133% of stress permitted for the design loading condition but in no case shall exceed 80% of specified minimum yield strength of the material. 4.6 Except where otherwise indicated in the Owner's drawings/ specifications, if the stiffening of the shell and/or roof is necessary, the same shall be stiffened from outside. 4.7 Reinforcement pads in tank connections shall be provided as per applicable code & the reinforced connection shall be completely preassembled into a shell plate. The completed assembly including the connection shall be thermally stress-relieved as per API Standard 620, if specified. 4.8 All welding shall be done as per IS-816, IS-817 and IS-9595, latest revision as applicable. All welds are to be continuous welds. Bidder shall clearly state in his offer the make and type of welding rods proposed by him for fabrication. Inspection of welding shall be carried out in accordance to IS-822, IS-9595. Welding sequence shall be adopted in such a way so as to minimise the distortion due to welding shrinkage, Contractor shall indicate in his Drawing the sequence of welding proposed by him duly approved by Owner/Consultant.		

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4.9	<u>TANK CONNECTIONS</u>	
4.9.1	Bidder shall furnish all piping material required for the tank connections.	
4.9.2	Unless otherwise specified, for all flanged connections Bidder shall furnish suitable counter flanges and the necessary nuts, bolts, gaskets etc.	
4.9.3	Flange faces of all nozzles shall be machined and square with the vessel centerlines.	
4.9.4	Unless otherwise stated, bolts and nuts shall be of hexagonal head conforming to IS-1367, latest revision.	
	The material and thickness of gaskets shall be suitable for the specified service. On completion of hydraulic test, Contractor shall replace the gaskets used during testing at his own cost.	
4.9.5	All tanks shall be provided with connections for drains, vents and overflow.	
4.10	<u>ACCESSORIES</u>	
4.10.1	Level Indicator	
	Float operated or tubular gauge glass type indicator of high grade workmanship shall be provided on each tank. Tank of height not exceeding 3 m shall have tubular gauge glass and others shall have float operated level Indicator. For tubular gauge glass, isolating valves and protective guards against mechanical shock shall be provided.	
4.10.2	Level Switch	
	Where specified, level switch of approved make & type shall be furnished along with instrument root valves. Repeat accuracy of operation shall be $\pm 1\%$ of the full range. At least two level switches, one for High level actuation and other for Low Level actuation, shall be provided for each tank.	

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4.10.3	Where the tank height exceeds 2 M, vertical ladder is to be provided with cage.	
4.10.4	Top Manhole shall be provided in all tanks. Manhole size shall be 600 NB (minimum). The tank shall be provided with accessories as indicated in the Specification. All the accessories shall conform to relevant Indian Standards. The following broad guidelines are given for some of the accessories.	
4.11	When installation of tank is specified the recommendation regarding installation in BS EN 12285-1 & BS EN 12285-2 shall be followed in general. In addition to those recommendations, the following shall also be taken care of.	
4.12	The finished tank grade for cylindrical tank shall be crowned from the outer periphery to the centre with a slope. The sloping factor shall be taken as 1:36 unless otherwise specified	
5.0	<u>PAINING</u>	
5.1	Surface preparation: Internal - Sand blasting and External - wire brushing.	
5.2	Primer	(a) Internal - epoxy based Zn rich primer (b) External - Synthetic Red lead
5.3	Finish Coat	(a) Internal - Coal tar epoxy (b) External - Synthetic enamel
5.4	Outside of bottom surface shall have 3 coats of Bitumastic paints.	

CONSULTANT : PROCON ENGINEERS
