



TD-106 Rev No. 00  Form No.		<b>PRODUCT STANDARD PUMPS HYDERABAD</b>		<b>FP60340</b>																	
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<b>COPYRIGHT AND CONFIDENTIAL</b>  The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED, It must not be used directly or indirectly in any way detrimental to the interest of the company.		<b><u>TECHNICAL SPECIFICATION FOR ABSORBER SLURRY RECIRCULATION PUMP</u></b>																			
		<p><b>1. Intent of specification</b></p> <p>This specification is intended to cover the design, engineering, manufacturing, inspection and testing at manufacturer's works, packing and delivery to site of Slurry Recirculation pump. This Slurry Recirculation pump is a component of the slurry recirculation system of FGD.</p> <p>Each unit of 250/500/660/800MW is associated with an FGD system. Each FGD system shall have recirculation pumps located inside Recirculation pump &amp; Oxidation blower house. The pumps shall be suitable for outdoor application. The pumps shall be driven by a constant speed motor.</p> <p>The offered pump model shall be proven and must meet the proven-ness criteria indicated at clause 3. The list of deviations/exceptions with respect to the specification shall be submitted as per annexure-4. Deviations not listed in the format shall not be considered. No deviations/exceptions shall be permitted without the approval of purchaser.</p> <p>In case of additional requirement of instrumentation, controls and other accessories/auxiliaries for safe, reliable and trouble-free operation of the pump, necessary reasons for recommendation shall be furnished and the same shall be included in scope of supply with the purchaser's approval.</p> <p><b>2. Scope of supply</b></p> <p>Supplier scope shall include Design, Supply, Engineering Coordination and Supervision of Erecting &amp; Commissioning of slurry recirculation pump along with its base plate, instrumentation, as well as start-up spares and special tools and tackles.</p> <p><b>3. Applicable codes and standards</b></p> <p>The design, manufacture and performance testing of the pumps as specified herein shall comply with requirement of all applicable codes in particular the following.</p> <table border="0"> <tr> <td>1. ANSI HI 12.1~12.6:</td> <td>Rotodynamic Centrifugal slurry pumps</td> </tr> <tr> <td>2. API 682:</td> <td>Shaft sealing system for centrifugal &amp; rotary pump</td> </tr> <tr> <td>3. API 670:</td> <td>Machinery protection system</td> </tr> <tr> <td>4. ANSI B16.5, B16.47:</td> <td>Pipe flanges and flange fittings</td> </tr> <tr> <td>5. ANSI B16.9:</td> <td>Butt weld fittings</td> </tr> <tr> <td>6. ANSI B16.11:</td> <td>Forged steel fittings, socket welded and threaded</td> </tr> <tr> <td>7. ASTM:</td> <td>For various materials &amp; tests</td> </tr> <tr> <td>8. ASME sec VIII div. 1</td> <td></td> </tr> <tr> <td>9. ISO 9906</td> <td>Rotodynamic pumps hydraulic performance acceptance</td> </tr> </table>				1. ANSI HI 12.1~12.6:	Rotodynamic Centrifugal slurry pumps	2. API 682:	Shaft sealing system for centrifugal & rotary pump	3. API 670:	Machinery protection system	4. ANSI B16.5, B16.47:	Pipe flanges and flange fittings	5. ANSI B16.9:	Butt weld fittings	6. ANSI B16.11:	Forged steel fittings, socket welded and threaded	7. ASTM:	For various materials & tests	8. ASME sec VIII div. 1	
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Ref. Doc		Revisions:	Prepared:	Checked:	Approved:	Date:															
		Refer record of revisions	JAISRI	SURESH	ASJK	25.03.2022															

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**4. Provenness Criteria**

Supplier shall have previous experience of design, manufacturing, supplying, erecting and commissioning of the recirculation pump for Wet Limestone based FGD system for at least two (2) no's of PUMPS, each of capacity 9500 m3/hr or higher, in a pulverized coal fired power generating units such that the pump should have been in successful operation for a period of not less than two (2) years prior to January 2019. Documentary evidence as per annexure-3 at clause 23.3, shall be submitted along with the offer.

**5. Variant table**

Project	:	Patratu STPP, 3x800MW	Kahalgaon TPP, 2x210MW+2x210MW	Kahalgaon TPP, 3x500MW	WBPDC SAGARDIGHI 1X660 MW
Ultimate Customer	:	NTPC	NTPC	NTPC	Non NTPC
Location	:	Ramgarh, Jharkhand, India	Bihar, India	Bihar, India	Sagardighi, West Bengal, India
Service	:	Continuous	Continuous	Continuous	Continuous
Installation	:	In-door	In-door	In-door	In-door
Total number of units	:	3 units of 800MW	4 units of 210MW	3 units of 500MW	1 Units of 660 MW
Total pumps in each unit	:	8	3	4	5
Stand-by pumps per unit	:	1	1	1	1
Total number of working pumps	:	21	4	9	4
Total number of pumps	:	24	6	12	5
Variant	:	Var. 01	Var. 02	Var. 03	Var.04
Material code	:	FP9760340011	FP9760340020	FP9760340038	FP9760340046

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**6. Design input data**

**6.1 Pump operating parameters**

Discharge flow	13,350 m <sup>3</sup> /hr	13,995 m <sup>3</sup> /hr	11,420 m <sup>3</sup> /hr	11,830 m <sup>3</sup> /hr
Total Head developed	15.30 m H	17.10 m H	15.70 m H	20.3 m H
Medium to be handled	Gypsum slurry	Gypsum slurry	Gypsum slurry	Gypsum slurry
Operating Temperature	~62 deg C	~62 deg C	~62 deg C	~62 deg C
Type of Recirculation pump	Horizontal, Centrifugal pump (non-clogging type)			
Nozzle Orientation	End Suction- Top Discharge			
Seal Type	Mechanical seal with external flushing			
Duty	Continuous operation			
Location	Outdoor			
Drive type	Motor driven			
Acceptable noise level	85 dBA (at 1-meter from pump centreline)			
NPSH(A)	12.29 mlc	9.30 mlc	9.31 mlc	9.10 mlc
Variant	Var. 01	Var. 02	Var. 03	Var.04

**6.2 Slurry Analysis**

Slurry to be handled	Gypsum Slurry			
Chloride Content	25,000 ppm			<20,000 ppm
Specific Gravity at pump suction (t/m <sup>3</sup> )	1.177 @ design point	1.212	1.214	1.206
	1.163 @guarantee Point.	1.211	1.212	1.205
Vapour Pressure at Pump(kg/cm <sup>2</sup> )	0.223	0.228	0.228	0.256
Viscosity of slurry	0.01 Pa.S	0.01 Pa.S	0.01 Pa.S	
Concentration of Solid	25% wt.	30% wt	30% wt	
SiO <sub>2</sub> Content	4 to 6 g/l			
pH	Normal = 4.0 – 7.0			
	Design = 4.0 – 8.0			
Slurry Temperature ( deg C)	62 (normal)	61.2	65.2	
	70 (design)	71.0		
Maximum solid particle size	150 mesh(140 microns)			
Normal solid particle size, d 50	325 mesh(43 microns) & fine particles			
Variant	Var. 01	Var. 02	Var. 03	Var.04

Constituents	Units	Value
Calcium as CaCO <sub>3</sub>	ppm	105
Magnesium as CaCO <sub>3</sub>	ppm	81
Sodium as CaCO <sub>3</sub>	ppm	70
Potassium as CaCO <sub>3</sub>	ppm	7
Iron as Fe	ppm	0.5
Bicarbonate as CaCO <sub>3</sub>	ppm	180
Chlorides as CaCO <sub>3</sub>	ppm	60
Sulphate as CaCO <sub>3</sub>	ppm	23
Silica	ppm	17
pH	-	7 to 7.8
Turbidity	NTU	10
Variant		Var. 01

# PRODUCT STANDARD

## PUMPS

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**For Var 02 & 03****DESIGN CLARIFIED WATER ANALYSIS**

S.No	Constituent	As	mg/l (except pH & turbidity)
1.	Calcium	CaCO <sub>3</sub>	155
2.	Magnesium	CaCO <sub>3</sub>	95
3.	Sodium + Potassium	CaCO <sub>3</sub>	117
4.	Chloride	CaCO <sub>3</sub>	40
5.	Sulphate	CaCO <sub>3</sub>	69
6.	Alkalinity	CaCO <sub>3</sub>	258
7.	Iron(total)	Fe	0.3
8.	Total Silica	SiO <sub>2</sub>	12
9.	pH value	---	6.6 – 7.2
10.	Turbidity	NTU	20

Note: At the outlet of PT (CW) Plant.

**PROCESS WATER / CW BLOW DOWN WATER ANALYSIS**

S.No	Constituent	As	mg/l (except pH & turbidity)
1.	Calcium	CaCO <sub>3</sub>	620
2.	Magnesium	CaCO <sub>3</sub>	380
3.	Sodium + Potassium	CaCO <sub>3</sub>	468
4.	Bicarbonates	CaCO <sub>3</sub>	1032
5.	Chloride	CaCO <sub>3</sub>	160
6.	Sulphate	CaCO <sub>3</sub>	276
7.	Sulphate	CaCO <sub>3</sub>	276
8.	Iron(total)	Fe	1.2
9.	Total Silica	SiO <sub>2</sub>	48
10.	pH value	---	8.8 – 9.2
11.	Turbidity	NTU	80

Note : The C.W system is expected to operate at about 4Cycles of Concentration.

**For Var 04**


Constituents	Units	Value
Calcium as CaCO <sub>3</sub>	ppm	105
Magnesium as CaCO <sub>3</sub>	ppm	52
Sodium & Potassium as CaCO <sub>3</sub>	ppm	138
Hydrogen (FMA) as CaCO <sub>3</sub>	ppm	----
Total Cations as CaCO <sub>3</sub>	ppm	295
Bi-Carbonates as CaCO <sub>3</sub>	ppm	196.5
Carbonate as CaCO <sub>3</sub>	ppm	----
Chloride as CaCO <sub>3</sub>	ppm	41
Sulphate as CaCO <sub>3</sub>	ppm	57.5
Nitrate as CaCO <sub>3</sub>	ppm	----
Total Anions as CaCO <sub>3</sub>	ppm	295
M.O.Alkalinity as CaCO <sub>3</sub>	ppm	196.5
P.Alkalinity as CaCO <sub>3</sub>	ppm	----
Total Hardness as CaCO <sub>3</sub>	ppm	157

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S.No	Condition	Required total flow rate m3/hr	Required Pump Head m	Each Pump Capacity (m3/hr)	Pump Efficiency (%)	Shaft Power consumption (KW)	Remarks
1	7 Pumps in Continuous operation	93,450	15.3	13,350	> <b>87%</b>	##	
2	6 Pumps in Continuous operation	84,300	13.9	14,050	> <b>87%</b>	##	Power loading guarantee point

**Variant no. 2**

6.6.4.2 Two (02) pumps will be in continuous operation.

6.6.4.3 In order to optimize power consumption of FGD system at part load operation, slurry recirculation pump shall be capable of variable speed operation and shall be driven by Variable frequency drive (VFD). The operating range of the pump shall be 40 to 120% of duty point and pump shall be capable of operation.

S.No	Condition	Required total flow rate m3/hr	Required Pump Head m	Each Pump Capacity (m3/hr)	Pump Efficiency (%)	Shaft Power consumption (KW)	Remarks
1	2 Pumps in Continuous operation	27,990	17.10	13,995	> <b>90%</b>	##	

**Variant no. 3**

6.6.4.2 Three (03) pumps will be in continuous operation.

6.6.4.3 In order to optimize power consumption of FGD system at part load operation, slurry recirculation pump shall be capable of variable speed operation and shall be driven by Variable frequency drive (VFD). The operating range of the pump shall be 40 to 120% of duty point and pump shall be capable of operation.

S.No	Condition	Required total flow rate m3/hr	Required Pump Head m	Each Pump Capacity (m3/hr)	Pump Efficiency (%)	Shaft Power consumption (KW)	Remarks
1	3 Pumps in Continuous operation	34,260	15.7	11,420	> <b>90%</b>	##	


**Variant no. 4**

6.6.4.2 Four (04) pumps will be in continuous operation.


6.6.4.3 In order to optimize power consumption of FGD system at part load operation, slurry recirculation pump shall be capable of variable speed operation and shall be driven by Variable frequency drive (VFD). The operating range of the pump shall be 40 to 120% of duty point and pump shall be capable of operation.


S.No	Condition	Required total flow rate m3/hr	Required Pump Head m	Each Pump Capacity (m3/hr)	Pump Efficiency (%)	Shaft Power consumption (KW)	Remarks
1	4 Pumps in Continuous operation	47,320	20.3	11,830	> <b>90%</b>	≤873 KW	


**## To be indicated by supplier**


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<p style="text-align: center;"><b>COPYRIGHT AND CONFIDENTIAL</b></p> <p>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED. It must not be used directly or indirectly in any way detrimental to the interest of the company.</p> <p style="text-align: right;">Ref Doc</p>		<p>6.6.5 Pumps shall be sequentially stopped, one after the other.</p> <p>6.6.6 In the event of power failure, all the running pumps will be shutdown instantaneously, i.e. at the same time. Pumps discharge valve will close fully in 15 sec. During this time, pump shall be capable of handling the reverse flow.</p> <p><b>7. Technical Requirements</b></p> <p><b>7.1</b> All recirculation pumps shall be identical and interchangeable.</p> <p><b>7.2</b> The pumps shall be designed for continuous operation. The pump shall be single stage centrifugal type, capable of delivering the rated flow at rated head, duty parameters indicated at clause 6.1.</p> <p><b>7.3</b> The pumps shall circulate the operating liquid from the absorber sump to the spray nozzles in the absorber.</p> <p><b>7.4</b> The pumps shall be resistant to wear and be equipped with flushing devices to prevent sedimentation. They shall be designed and installed to allow easy replacements, repair and maintenance.</p> <p><b>7.5</b> The pump bearing housings shall be equipped with oil level indicators and the collecting equipment for leakage shall made of corrosion resistant material.</p> <p><b>7.6</b> The pump shall be designed for a service life of 20 years and at least 18000 hours of un-interrupted operation.</p> <p><b>7.7</b> All the parts coming in contact with the slurry shall be provided with replaceable rubber/elastomer liners suitable to the media handled. The supplier can also offer a Hi-chrome alloy lined pump, Carbon steel/CI lined with high alloyed stainless steel, a Silicon Carbide impeller and SiC lining for casing if the Supplier has supplied a similar pump for a previous installation for similar service. The material used by the contractor shall be proven in previous installations.</p> <p><b>7.8</b> The pump casing shall be designed to withstand a pressure of 1.5 times the maximum possible pump shut off pressure under maximum suction pressure condition.</p> <p><b>7.9</b> Flushing water lines and drains are to be supplied for each pump handling the prevailing water to avoid corrosion even if the pump is out of operation for extended periods.</p> <p><b>7.10</b> Pumps must be carefully selected to ensure that the net positive suction head available under all operating conditions will be adequate. The NPSH values are to be referred to the least favorable operating conditions such as lowest atmospheric pressure, lowest level of water on the suction side of the pump and highest temperature of the pumped fluid. An adequate safety margin of normally greater than 1m to the max NPSH required shall be provided. NPSH(R) at 120% of rated flow shall have margin over NPSH (A).</p> <p><b>7.11</b> The Pump flow &amp; head characteristics shall be such that within the operation range the head will continuously increase with decreasing flow. Shut off head being at least 20% higher than the duty point head.</p> <p><b>7.12</b> Pumps shall have stable head-capacity characteristics curve from run-off to shut-off. Shut-off head should be minimum 125% of Best Efficiency Point (BEP).</p> <p><b>7.13</b> Venting valve shall be fitted to all pumps at suitable points on the pump casing. Drainage facilities shall be provided on the pump casing or adjacent pipe work to facilitate the dismantling of pumps.</p> <p><b>7.14</b> Pumps shall be designed such that they are not damaged during reverse rotation at up to 150% of design RPM, at full discharge head in the event where one pump trips while the other pumps are operational.</p> <p><b>7.15</b> Selection of Duty point should preferably be at BEP (Best Efficiency Point). Selection point beyond 105% of BEP is not acceptable. It should be noted that head variation is due</p>		





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<p align="center"><b>COPYRIGHT AND CONFIDENTIAL</b></p> <p>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED. It must not be used directly or indirectly in any way detrimental to the interest of the company.</p>		Ref Doc	<p>8.3.6 Seal shall have zero visible leakage. However, quantity of leakage, if unavoidable, pump should have a provision of collecting and draining the same to nearby pit without corroding the pump frame.</p> <p>8.3.7 Mechanical seals shall be fitted and installed in the pump before shipment and shall be clean. Seal shall have provision for locking during transit and when not in operation. Mechanical seals vent/drain holes shall be plugged during shipping</p> <p>8.3.8 Intention of the specification is not to specify Type of Seal, Seal design, spring configuration, Seal configuration, Balanced or Unbalanced type etc. Pump manufacturer to decide the same along with seal manufacturer.</p> <p>8.3.9 Seal life has to be guaranteed, taking into consideration all its components for 25000 hrs. If the seals fail before the completion of guaranteed period, the same should be replaced free of cost by the Supplier.</p> <p><b>8.3 Shaft and Shaft Sleeve</b></p> <p>8.4.1 Pump shaft shall be sized to transmit the maximum possible output from the motor.</p> <p>8.4.2 The pump shaft to be so dimensioned that the maximum permissible torque of the shaft is higher than the maximum transmissible torque.</p> <p>8.4.3 Pumps shall operate smoothly throughout the speed range up to their operating speeds. The first coupled critical speed must be at least 20% higher than the maximum operating speed. The determination of the shaft diameter and the distance between two consecutive bearings must include a sufficiently large safety margin to satisfy this condition.</p> <p>8.4.4 Shafts shall be conservatively designed to transmit maximum power required and to assure rigidity. Shafts shall be machined and ground to close tolerances and shall be tapered to permit easy assembly &amp; withdrawal of the seals and bearings.</p> <p>8.4.5 Shaft shall run in high precision heavy duty roller bearings.</p> <p>8.4.6 The shaft shall be finished to close tolerance at the rotor, coupling and bearing diameters.</p> <p>8.4.7 Shaft shall be made of carbon steel. No exposed part of the shaft shall come in contact with the medium handled.</p> <p>8.4.8 Shaft sleeve should be CD4M Cu ASTM A-743 or equivalent. Sleeve should have this as a guaranteed value/parameter to prevent wear and corrosion of mating surface. Manufacture to indicate the diameter in data sheet.</p> <p>8.4.9 Shaft shall have a keyed joint at impeller hub. Threaded connection between impeller and shaft is not acceptable.</p> <p><b>8.4 Bearings</b></p> <p>8.5.1 The bearings may be ball, roller or sleeve bearing. The bearings shall be designed to take the necessary radial load as well as the net axial thrust. Bearings shall be lubricated properly and sized for an operating life of 25,000 hours on the basis of maximum load. Bearing lubrication provided shall be such that visual inspection of lubricant level is possible.</p> <p>8.5.2 The bearings shall be of automatic oil lubricated type. Bearing Temperature transmitter shall be provided with local monitoring of the bearing metal temperature. In case, external cooling water is required, flow, pressure, etc. shall be specified.</p> <p>8.5.3 Bearing housings shall be designed such that they can be replaced without removing the pump from its mounting. Supplier shall inform the bearing withdrawal length for suitable selection of coupling. Bearing housings shall be effectively protected against the ingress of water, pumped fluid and dust by suitable nonferrous deflectors.</p>	

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<p align="center"><b>COPYRIGHT AND CONFIDENTIAL</b></p> <p>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED. It must not be used directly or indirectly in any way detrimental to the interest of the company.</p>		Ref Doc	<p>8.5.4 Bearing temperature transmitter shall be provided with local monitoring of the bearing metal temperature of pump. Bearing temperature Transmitter shall provide signals to FGD DCS for continuous monitoring.</p> <p>8.5.5 Lubricating oil will be the responsibility of pump manufacturer. Hence, manufacturer has to make arrangement of first fill of oil at installation, and at commissioning stage. Quantity of oil and its grade is to be indicated in Drawing and Operation Manual.</p> <p><b>8.5 Base Plate</b></p> <p>8.5.1 Base plate shall be provided for the pump and it shall be rigidly constructed, adequately braced and provided with finish pads for mounting the pump.</p> <p>8.5.2 Base plate must have provision for jacking the pump in both directions of base plate for alignment. Similarly, provision must be provided for alignment of shaft in vertical plane.</p> <p>8.5.3 Pump manufacturer is to supply base plate along with Foundation bolt &amp; Nut, shims/spacers, "Taper wedge" and the necessary fastener for Pump with Base plate.</p> <p>8.5.4 Base plate must be provided with a trough, material of which must be compatible to pumping liquid. Leaked liquid collected in trough, can be systematically routed to designated point.</p> <p>8.5.5 Base plate must be stress-relieved for any residual welding stress and certificate to that effect is to be submitted as per inspection requirement.</p> <p><b>8.6 Accessories</b></p> <p>8.6.1 Pressure Gauges</p> <p>8.6.1.1 Pressure Gauges shall be provided at suction &amp; discharge of each pump. Pressure gauges of class 1.6 or better must be used. Pressure instrument for measurement of steady pressure at varying conditions shall operate in a band centered on 60% of its maximum range. Pressure gauges shall have a dial size of 160 mm.</p> <p>8.6.2 Provision for Vibration Monitoring:</p> <p>8.6.2.1 Suitable provision/pads for mounting vibration sensors, Key phase sensors shall be provided on the pump. For each bearing there shall be provisions for Two (02) No's of Vibration sensors (X and Y Axis) for vibration measurement. Provisions shall be provided in line with API 670 Vth Edition Standard These provisions shall be covered suitably. Details to be provided along with the offer.</p> <p>8.6.3 Temperature elements:</p> <p>8.6.3.1 Temperature elements wherever provided shall be duplex 4 wire type RTDs.</p> <p>8.6.3.2 All RTD connections along with signal cables shall be terminated to Junction Box. Junction Box shall be provided along with Gear Box &amp; Pump with 20% spare terminals.</p> <p>8.6.3.3 Triple redundancy shall be supplied for parameters concerning the safe operation of the pump, Double redundancy shall be supplied for interlock and alarm signals.</p> <p><b>9. General Requirements</b></p> <p><b>9.1</b> Metric unit shall be used in the drawings and any displays on the equipment. Unit of pressure shall be in dual scales of kPa and kg/cm<sup>2</sup> (G). For instance the pressure gauges should have dual unit's indication.</p> <p><b>9.2</b> Descriptions in the drawings, documents and in the displays shall be in English.</p> <p><b>9.3</b> The equipment shall be designed to withstand the corrosive and moist environment in which these are proposed to operate.</p> <p><b>9.4</b> Noise level produced by the rotating equipment shall not exceed 85 dB measured at a distance of 1.0 meters from the source in any direction and 1.5m above operating floor. Predicted sound pressure levels for the pump drive assemblies shall be submitted as part</p>	


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<p style="text-align: center;"><b>COPYRIGHT AND CONFIDENTIAL</b></p> <p>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED. It must not be used directly or indirectly in any way detrimental to the interest of the company.</p>		Ref Doc	<p><b>9.25</b> All inspection &amp; testing shall be carried out based on the following documents:</p> <p>9.25.1 Relevant Standards</p> <p>9.25.2 Specifications</p> <p>9.25.3 Approved drawings</p> <p>9.25.4 Data Sheets</p> <p>9.25.5 Calibration certificate for all the measuring instruments</p> <p>9.25.6 Supplier should also coordinate in getting the Material Dispatch clearance certificate and all types of Inspection Certificates from the end customer along with BHEL</p> <p><b>9.26</b> Providing shim plates for erection of the pump at site shall be in the scope of Supplier.</p> <p><b>9.27</b> During detail engineering, Supplier to strictly adhere to BHEL drawing formats, document numbering, quality plan formats.</p> <p><b>9.28</b> The identification and numbering of equipment, systems, items, etc. of supply, as well as of all documents and drawings shall be in accordance with the VGB guideline RDS-PP (Reference Designation System for Power Plants - KKS system).</p> <p><b>9.29</b> Complete detail engineering drawings, calculations, selection of components etc. shall be reviewed &amp; subject to approval of BHEL/end customer during detail engineering.</p> <p><b>9.30</b> Supplier shall furnish necessary inputs &amp; drawings of all equipment in editable Auto CAD/MS-Word /Excel format.</p> <p><b>9.31</b> During detail engineering, successful Supplier shall ensure flow of drawings/documents as per schedule. Any comments from BHEL/end customer should be addressed timely by the Supplier.</p> <p><b>9.32</b> Supplier shall submit the signed and stamped copy of all the pages which constitutes this technical enquiry specification signed by authorized signatory and clearly mentioning each clause under following two categories to avoid any ambiguity in scope understanding &amp; the scope division along with technical offer.</p> <p>9.32.1 “Accepted without deviation and considered in scope of work” [or]</p> <p>9.32.2 “Not considered in scope of work”</p> <p><b>10. Packing</b></p> <p><b>10.1</b> Packing shall be as per relevant product packing specification.</p> <p><b>10.2</b> Cardboard containers shall be enclosed in a solid wooden container</p> <p><b>10.3</b> Equipment and process materials shall be packed and semi-knocked down, to the extent possible, to facilitate handling and storage and to protect bearings and other machine surfaces from oxidation. Each container, box, crate or bundle shall be reinforced with steel strapping in such a manner that breaking of one strap will not cause complete failure of packaging. The packing shall be of best standard to withstand rough handling and to provide suitable protection from tropical weather while in transit and while awaiting erection at the site.</p> <p><b>10.4</b> Equipment and materials in wooden cases or crates shall be properly cushioned to withstand the abuse of handling, transportation and storage. Packing shall include preservatives suitable to tropical conditions. All machine surfaces and bearings shall be coated with oxidation preventive compounds. All parts subject to damage when in contact with water shall be coated with suitable grease and wrapped in heavy asphalt or tar impregnated paper.</p> <p><b>10.5</b> Crates and packing material used for shipping will become the property of end customer.</p> <p><b>10.6</b> Packaging or shipping units shall be designed within the limitations of the unloading facilities of the receiving ports and the ship used. It shall be the Supplier’s responsibility to investigate these limitations and to provide suitable packaging and shipping to permit</p>	

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<p style="text-align: center;"><b>COPYRIGHT AND CONFIDENTIAL</b></p> <p>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED. It must not be used directly or indirectly in any way detrimental to the interest of the company.</p> <p style="text-align: right;">Ref Doc</p>		<p>11.1.4.1 Casing: Material test, Magnetic particle (MPI), DP and Hydro test as applicable</p> <p>11.1.4.2 Impeller- DPT and MPI as applicable</p> <p>11.1.4.3 Shaft- Ultrasonic (UT), DPT and MPI</p> <p>11.1.4.4 Sleeve- DP and Hardness test/ Manufacturer's recommendation</p> <p>11.1.4.5 Mechanical Seal- Manufacturer's recommendation.</p> <p>11.1.4.6 Replaceable Rubber liner- Shore Hardness, Class and Type certificate</p> <p>11.1.5 Once mounting is finished, performance test will be conducted on each pump to determine the characteristic curves. The mechanical running &amp; performance testing shall be performed &amp; witnessed.</p> <p>11.1.6 NPSH Test, Vibration test and Noise level test shall be witnessed at shop.</p> <p>11.1.7 For surfaces with rubber lining Welding shall be visually inspected to verify the absence of rough area and unacceptable transition between surfaces which prevent the adequate adherence of rubber. The acceptance criteria shall be as per latest standard.</p> <p>11.1.8 For surfaces with rubber lining, degree of cleaning shall be visually checked before the application of the coating. There must be no area with oxidation, dirt or partially or generalized corrosion defects.</p> <p>11.1.9 Test certificates shall be issued for each lot of raw material used in the coating, corresponding to specific weight and traction resistance.</p> <p>11.1.10 For surfaces with rubber lining, adherence test shall be conducted on production samples. Adherence test shall be conducted on the actual surface through hammering. In order to verify the absence of air packets (or) surface without adherence.</p> <p>11.1.11 For surfaces with rubber lining, Coating thickness shall be checked at 100%.A High voltage porosity test will be conducted on 100 % of the coated surface.</p> <p><b>11.2 General Inspection requirements to be considered are as below:</b></p> <p>11.2.1 Supplier shall furnish written copies of shop production, fabrication and quality test procedures and drawings to be used for review by BHEL/end customer prior to manufacture. Inspection of above mentioned tests by BHEL representative at Supplier's works is envisaged.</p> <p>11.2.2 The Supplier shall furnish performance test procedure along with standard. The test procedure shall be submitted for approval by BHEL.</p> <p>11.2.3 Out of total Recirculation Pumps, One Number of Recirculation Pump will be inspected at the Supplier's works before dispatch or where the test facilities are available.</p> <p>11.2.4 The Supplier shall conduct performance test for the remaining pumps and submit the reports.</p> <p>11.2.5 A dynamic balancing certificates stating that the rotating assembly has been balanced dynamically shall be sent to BHEL within one (1) week of the successful completion of balancing.</p> <p>11.2.6 Acceptance tolerance of actual versus guaranteed performance for capacity, head, efficiency and power absorbed shall be as per applicable standard.</p> <p>11.2.7 Vibration levels shall be measured during shop running/performance tests.</p> <p>11.2.8 Contract shaft seals shall be used during shop tests, unless the seal design is unsuitable for the shop-test condition.</p> <p>11.2.9 Recirculation pumps shall not be released for shipment, until shop tests data and performance tests curves have been approved by BHEL/end customer.</p> <p>11.2.10 Supplier should furnish performance guarantee as per applicable standard, guarantee for the design, manufacture, material and safe operation of the equipment.</p>		



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<p style="text-align: center;"><b>COPYRIGHT AND CONFIDENTIAL</b></p> <p>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED. It must not be used directly or indirectly in any way detrimental to the interest of the company.</p> <p style="text-align: right;">Ref Doc</p>		<p>11.2.11 BHEL shall witness the test at Supplier's works and a notice of minimum three (3) weeks shall be given for attending the inspection.</p> <p>11.2.12 Supplier to arrange all calibrated gauges, Instruments during inspection.</p> <p>11.2.13 Mechanical running and the performance test shall be carried out. Supplier to inform in advance the Motor rating for the shop test and inspection.</p> <p>11.2.14 The performance test may be carried out using water at shop and shall be converted to the design condition.</p> <p><b>12. Painting</b></p> <p>The paint schedule is not yet specified by end customer, this will be specified shortly during execution of the project.</p> <p><b>13. Spares, Tools &amp; Tackles</b></p> <p><b>13.1 Start-up &amp; Commissioning Spares</b></p> <p>Start-up &amp; Commissioning Spares shall be part of the main supply of the Recirculation pumps. Start-up &amp; commissioning spares are those spares which may be required during the start- up and commissioning of the equipment/system. Supplier shall provide an adequate stock of such start up and commissioning spares for the equipment erection and commissioning. The spares must be available at site before the equipment is energized. These start-up &amp; commissioning spare part list shall not be included in "Initial Spare Parts List".</p> <p><b>13.2 Recommended Spares</b></p> <p>Suppliers shall also furnish the recommended spares list along with the offer. Supplier shall provide a "Recommended Spare Parts List" which shall comprise of all items of the Initial Spare Parts List as well as other spares required for long term routine/planned and breakdown maintenance. Supplier shall indicate all details for each item of aforesaid Recommended Spare Parts List, such as Supplier's/ Original equipment manufacturers (OEM's) name and location, drawings, normal delivery period, quantity, service life, Supplier's/OEM's serial numbers and price etc. The format and content of the final spare parts list shall be agreed in the basic/detailed engineering phase. Then the final spare parts list shall be submitted by the Supplier to BHEL for approval not later than eighteen (18) months prior to the Scheduled Commercial Operation Date (COD) of the 1st Unit. The Supplier shall name OEM/ three (3) vendors with complete address for each of the spare parts.</p> <p>Supplier shall quote for the "Recommended Spare Parts List", however it shall not be considered for L1 evaluation, but these spares items shall remain available for order anytime during the first two (2) years commencing from COD of first unit, at the initial unit prices quoted in the offer as adjusted pursuant to the indexation mechanism approved by end customer. However, the end customer shall have the freedom to decide at its sole discretion to purchase spare parts either from OEM (according to quoted unit price as stated above) or directly from sub-vendors or from any other source.</p>		

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### 13.3 Mandatory Spares:


Project	Patratu STPP, 3x800MW	Kahalgaon TPP, 2x210MW+2x210MW	Kahalgaon TPP, 3x500MW	WBPDC SAGARDIGHI 1X660 MW
Impeller assembly	1 no. of each type	4 no. of each type	4 no. of each type	1 no. of each type
Pump Casing		1 no. of each type	1 no. of each type	
Casing liners-If applicable	1	1 set, 1 set shall be complete replacement	1 set, 1 set shall be complete replacement	1 no. of each type
Seals	4 set of each type	4 set of each type and size	4 set of each type and size	1 no. of each type
Bearings	1 no. of each type	1 no. of each type	1 no. of each type	1 no. of each type
Oil Cups-If applicable				
Shafts & Sleeve				
Pressure gauge		1 no. of each type	1 no. of each type	
Transmitters		1 no. of each type	1 no. of each type	1 no. of each type
Temperature Elements	2 no. of each type	2 no. of each type	2 no. of each type	
RTDs				100% of each type
Thermowell for RTD				2 no. of each type
Variant	Var. 01	Var. 02	Var. 03	Var.04


Supplier shall quote for the “Mandatory Spares Part List”, and it will be considered for L1 evaluation. Mandatory spare parts items shall not be mixed with the supply of the main equipment parts. Spares shall be sent in pre-decided lots in containers/secure boxes, distinctly marked in red color with boldly written “S” mark on each face of the containers. The packing shall be sufficient for a minimum of 10 years storage in a dry weatherproof building.


All spares shall be strictly inter-changeable with the pump parts. All the mandatory spares shall have same specification and quality plan.

### 13.4 Special Tools & Tackles


Any special tools & tackles required for disassembly, assembly or maintaining the pumps, shall be included in the quotation and furnished as part of the initial supply of the machine. List of special tools & tackles shall be decided by Supplier as per his proven practice. They shall be packaged in separate boxes with lugs and marked as “Special Tools”. Moreover levers and eyebolts for the removal of parts to be serviced shall be included in the supply of each individual equipment.


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<p style="text-align: center;"><b>COPYRIGHT AND CONFIDENTIAL</b></p> <p>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED. It must not be used directly or indirectly in any way detrimental to the interest of the company.</p> <p style="text-align: right;">Ref Doc</p>		<p><b>14. Performance Guarantee</b></p> <p>All performance tests for Recirculation pumps shall be carried out in accordance with any latest international codes/standards.</p> <p><b>14.1</b> Supplier shall furnish Performance guarantee for the design, manufacture, material, safe and trouble-free operation of the Recirculation pump and its accessories.</p> <p><b>14.2</b> Capacity and its associated head of the pump to be guaranteed.</p> <p><b>14.3</b> The Supplier shall ensure a design of the equipment to achieve an average target availability of 90%.</p> <p><b>14.4</b> All the wear parts of the pump shall be guaranteed for a minimum wear life of not less than 25000 hrs.</p> <p><b>14.5</b> Scheduled Maintenance (Minor Overhauls): Recommended intervals between maintenance outages shall be &gt;25000 hours operation.</p> <p><b>14.6</b> Scheduled Maintenance (Major Overhauls): Recommended intervals between maintenance outages shall be &gt;75000 hours operation.</p> <p><b>14.7</b> Noise level-≤85 dB (A) at 1m horizontal distance from equipment/enclosures and 1.5m above operating floor is to be guaranteed.</p> <p><b>14.8</b> Vibration levels measured on the non-rotating parts shall not exceed the zone limit “B” as defined in ISO 10816 at steady conditions and shall not exceed the zone limit “C” as defined in ISO 10816 at transient conditions.</p> <p><b>14.9</b> Acceptance tests to be carried out as per the procedure defined by the Supplier which shall be submitted for BHEL/end customer approval.</p> <p><b>14.10</b> In the event of unsuccessful performance test, Supplier shall take necessary remedial action at his cost and the performance test shall be repeated.</p> <p><b>15. Bid Evaluation Criteria for Power Consumption</b></p> <p><b>15.1 Power Guarantee</b> Supplier to specify the guaranteed Shaft power per Pump operating at the duty point in their offer</p> <p><b>15.2 Bid evaluation criteria for power consumption:</b> Power consumption quoted by Supplier shall be limited to the ceiling value specified below. Ceiling value for Shaft power of Recirculation pump (refer variant table) In case, Guaranteed Shaft power offered by the Supplier exceeds the ceiling value specified above, his bid price will be loaded for excess power consumption as per the formula given below. Adjustment factor for excess power consumption in USD = (GPC-CV) X PL X No's of Working pumps (as per variant table) GPC- Guaranteed Shaft Power Consumption quoted by Supplier in KW CV- Ceiling Value for Shaft Power Consumption PL- Power Loading @ 4060 USD/KW Exchange rate as applicable on price bid opening date will be considered. No Price advantage apart from NIL Power Loading will be given if Guaranteed Power consumption offered is less than the ceiling value.</p>		

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<p style="writing-mode: vertical-rl; transform: rotate(180deg);"> <b>COPYRIGHT AND CONFIDENTIAL</b>  The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED.  It must not be used directly or indirectly in any way detrimental to the interest of the company. </p>		<p style="writing-mode: vertical-rl; transform: rotate(180deg);">Ref Doc</p> <p><b>16. Liquidated Damages for Power Consumption</b></p> <p>If actual shaft Power Consumption during prove out (or) PG Test operating at the duty point exceeds the value guaranteed by the Supplier, liquidated damages for shortfall in performance shall be deducted from contract price as per the formula given below  Liquidated damage deductible in USD per pump = (GPC-APC) X P X No's of Working pumps (as per variant table), where</p> <ul style="list-style-type: none"> <li>• GPC- Guaranteed Shaft Power Consumption quoted by Supplier in KW</li> <li>• APC- Actual Shaft Power Consumption in KW</li> <li>• P- Penalty @ 4060 USD per KW</li> </ul> <p><b>17. Warranty</b></p> <p><b>17.1</b> The warranty period shall begin on the date of taking over by end customer or date of issuance of the provisional acceptance certificate for the unit (whichever occurs first) and shall end after twenty-four (24) months. Provided that the successful Supplier shall extend the provisions of this warranty to cover all repaired and replacement parts furnished under the warranty obligations hereunder, subject to the warranty period for the same being for a period of 24 months from the date on which replacement or renewal work is completed.</p> <p><b>17.2</b> In case of failure of the equipment to meet the guarantee, BHEL/end customer reserves the right to reject the equipment. However, BHEL/end customer reserves the right to use the equipment until new equipment supplied by Supplier meets the guaranteed requirement.</p> <p><b>18. First fill of Consumables</b></p> <p><b>18.1</b> Supplier's scope shall also include supply and filling of all consumable items for operation up to COD including top up requirements at the time of issuance of PAC/declaration of COD. All lubricants proposed for the plant operation shall be suitable for all operating and environmental conditions that will be met on site consistent with good maintenance procedures as instructed in the maintenance manuals.</p> <p><b>18.2</b> Detailed specifications for the lubricating oil, grease, other consumables if any, including items qualities and quantities required per month of the plant operation shall be furnished. On completion of erection, complete list of bearings/equipment giving their location and identification marks shall be furnished to end customer along with lubrication requirements. For each type and grade of lubricant recommended, Supplier shall list at least three equivalent lubricants manufactured by alternative companies.</p> <p><b>19. Conflict</b></p> <p>Supplier's equipment shall be designed for and shall meet the service, performance and minimum level of quality requirements specified. Supplier shall be solely responsible for advising end customer in writing of any conflicts between the specifications and Supplier's design, including performance and levels of quality. Supplier agrees that its obligations, liabilities and warranties shall not be diminished or extinguished due to its meeting the requirements of the Specification.</p>		


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<b>COPYRIGHT AND CONFIDENTIAL</b> The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED. It must not be used directly or indirectly in any way detrimental to the interest of the company.		Ref Doc	<p><b>20. Documentation</b></p> <p><b>20.1 Documents to be submitted along with the offer</b></p> <p>The Supplier shall submit all documents, drawings, diagrams and all such information, which are necessary to fully understand the offer for techno – commercial evaluation.</p> <p>The following information shall be furnished along with duly filled-in Technical Data sheets at Annexure I and guarantee schedule furnished at Annexure-II.</p> <ul style="list-style-type: none"> <li>20.1.1 Sectional Assembly, P&amp;ID diagram</li> <li>20.1.2 Performance curve</li> <li>20.1.3 Terminal point details.</li> <li>20.1.4 General Arrangement with civil loads and pocket details.</li> <li>20.1.5 Rotor GD2 (kg-m2)</li> <li>20.1.6 Torque Vs Speed curve</li> <li>20.1.7 Calculation of Motor rating, Bearing capacity and coupling selection.</li> <li>20.1.8 Bill of material along with ASTM or its equivalent materials.</li> <li>20.1.9 Overall space and headroom requirement during Erection, maintenance of pump.</li> <li>20.1.10 Erection, Operation &amp; Maintenance manual with lubrication schedule</li> <li>20.1.11 Procedure for shop / site performance tests</li> <li>20.1.12 Time schedule for delivery.</li> <li>20.1.13 Quality Assurance Plan.</li> <li>20.1.14 Make of all bought out items.</li> <li>20.1.15 Deviation list</li> <li>20.1.16 Spares list.</li> <li>20.1.17 Hoist / Crane requirement.</li> <li>20.1.18 Reference list of similar projects executed.</li> <li>20.1.19 List of proposed makes and vendors</li> <li>20.1.20 Training program and schedule for BHEL &amp; customer personnel</li> <li>20.1.21 Equipment maintenance schedules</li> </ul> <p><b>20.2 Documents to be submitted after award of contract</b></p> <p>The Successful Supplier shall submit necessary data, documents and drawings for review, approval with requirements specified here under. However as minimum the following shall be submitted.</p> <ul style="list-style-type: none"> <li>20.2.1 Duly filled technical datasheet.</li> <li>20.2.2 General arrangement drawings indicating dimension and civil loading details.</li> <li>20.2.3 Motor Data for VFD.</li> <li>20.2.4 Recommended repair procedure etc.</li> <li>20.2.5 Operation and maintenance manuals.</li> <li>20.2.6 Assembly &amp; Dis-assembly sequence shall be submitted as a separate document prior to the submission of the Operation and Maintenance Manual.</li> <li>20.2.7 Erection schedule and component list.</li> <li>20.2.8 Successful Supplier shall submit Calculation for HT Motor power requirement for sizing HT Motor within 2 weeks from the date of ordering.</li> <li>20.2.9 The following performance curves of the pump shall be submitted: <ul style="list-style-type: none"> <li>20.2.9.1 Flow v/s Head</li> <li>20.2.9.2 Flow v/s NPSH</li> <li>20.2.9.3 Flow v/s Efficiency</li> <li>20.2.9.4 Flow v/s power consumption</li> </ul> </li> </ul>	



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							9	SEALS,4 SET OF EACH TYPE FOR VAR 02	4 set. of each type & Size	SET	FP9760340607	Var. 02
							10	BEARINGS, 1 NO. EACH TYPE FOR VAR 02	1 No. of each type	EA	FP9760340615	Var. 02
							11	TRANSMITTERS,1 NO/TYPE FOR VAR 02	1 No. of each type	SET	FP9760340623	Var. 02
							12	TEMP.ELEMENT,2 NO/TYPE FOR VAR 02	2 No. of each type	SET	FP9760340631	Var. 02
							13	GUAGES, 1 NO/TYPE FOR VAR 02	1 No. of each type	SET	FP9760340640	Var. 02
							14	IMPELLER ASSEMBLY, FOR VAR 03	4 No. of each type	EA	FP9760340658	Var.03
							15	PUMP CASING FOR VAR 03	1 No. of each type	EA	FP9760340666	Var.03
							16	CASING LINER FOR VAR NO 03	1 set., 1 set. shall be complete replacement	SET	FP9760340674	Var.03
							17	SEALS,4 SET OF EACH TYPE FOR VAR 03	4 set. of each type & Size	SET	FP9760340682	Var.03
							18	BEARINGS, 1 NO. EACH TYPE FOR VAR 03	1 No. of each type	SET	FP9760340690	Var.03
							19	TRANSMITTERS,1 NO./TYPE FOR VAR 03	1 No. of each type	SET	FP9760340704	Var.03
							20	TEMP.ELEMENT,2 NO/TYPE	2 No. of each type	SET	FP9760340712	Var.03
							21	GUAGES,1 NO./TYPE FOR VAR 03	1 No. of each type	SET	FP9760340720	Var.03
							22	IMPELLER ASSEMBLY, FOR VAR 04	1 no. of each type	EA	FP9760340739	Var.04
							23	CASING LINER, VAR NO 04	1 no. of each type	EA	FP9760340747	Var.04
							24	SEALS,1 NO. OF EACH TYPE FOR VAR 04	1 no. of each type	SET	FP9760340755	Var.04

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		26	TRANSMITTERS, 1 NO./TYPE FOR VAR 04	1 No. of each type	SET	FP9760340771	Var. 04
		27	RTDS, 100%/TYPE FOR VAR 04	1 No. of each type	SET	FP9760340780	Var. 04
		28	THERMOWELL FOR RTD, 2 NOS./TYPE FOR VAR 04	2 No. of each type	SET	FP9760340798	Var. 04
		29	THERMOCOUPLE, 2 NO./TYPE	2 No. of each type	SET	FP9760340828	Var. 04
		30	GAUGES, 1 NO./TYPE	1 No. of each type	SET	FP9760340810	Var. 04
		<p><u>Note to supplier regarding mandatory spares:</u></p> <ol style="list-style-type: none"> <li>Supplier shall clearly indicate with a P&amp;ID, drawings, various instruments used in the scope of supply and the highlight the mandatory spares diagrammatically to avoid any ambiguity. Supplier shall contact the purchaser in case of ambiguity, prior to submitting the offer. Revision/ Alteration after bid submissions shall not be considered.</li> <li>Impeller assembly shall include, impeller, impeller nut &amp; impeller keys.</li> <li>Complete casing shall be one to one replacement of the existing casing.</li> <li>Casing liners shall be a complete replacement of liners in the supplied pump, if applicable.</li> <li>Set of seals shall include Mechanical seal, oil seals, wear rings at impeller location, oil thrower &amp; oil guards in the entire scope of supply.</li> <li>Bearings shall include journal bearings, thrust bearings in the entire scope of supply.</li> <li>Set of Transmitters along with accessories shall include all the transmitters and its accessories where ever used in the entire scope of supply.</li> <li>Temperature elements with Thermowell shall include all temperature elements where ever used in the entire scope of supply.</li> <li>Local gauges along with accessories shall include all local gauges where ever used in the entire scope of supply.</li> </ol>					



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**22. ANNEXURES**


**22.1 Annexure-1, Technical Data Sheet**


S.No	Description	Data
<b>1</b>	<b>GENERAL</b>	
	a. Client	: Indicated in variant table.
	b. Project	: --do--
	c. End Customer	: --do--
	d. Location	: --do--
	e. Service	: --do--
	f. Installation	: --do--
	g. No of pumps for each unit	: --do--
	h. No of stand-by pumps per unit	: --do--
	i. Total number of pumps	: --do--
<b>2</b>	<b>MANUFACTURER DETAILS</b>	
	a. Model	: *
	b. Type	: Centrifugal (non- Clogging)
	c. Type of Driver	: Motor with Gearbox
<b>3</b>	<b>OPERATING CONDITION</b>	
	a. Medium to be handled	: Indicated in variant table.
	b. Maximum solid particle size	: --do--
	c. Normal solid particle size, d 50	: --do--
	d. Concentration of chloride	: --do--
	e. Viscosity of slurry	: --do--
	f. Concentration of slurry	: --do--
	g. Specific gravity of slurry	: --do--
	h. pH of slurry	: --do--
<b>4</b>	<b>PERFORMANCE DATA</b>	
	a. Capacity	m <sup>3</sup> /hr : *
	b. Head	M : *
	c. Pump efficiency	% : *
	d. BKW Normal / Maximum	KW : *
	e. Differential pressure (inclusive of losses)	Kg/cm2 : *
	f. Speed Maximum/ Normal/Minimum	rpm : *
	g. Noise level	dB(A) : *
	h. Performance curve	: *
<b>5</b>	<b>CONSTRUCTION DATA</b>	
	a. Manufacturer	:
	b. Model No.	: *
	c. Suction Rating / Size	: *


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<table border="1"> <tr> <td>d.</td> <td>Discharge Rating / Size</td> <td></td> <td>:</td> <td>*</td> </tr> <tr> <td>e.</td> <td>Type of rotor</td> <td></td> <td>:</td> <td>*</td> </tr> <tr> <td>f.</td> <td>Size of rotor Dia</td> <td>mm</td> <td>:</td> <td>*</td> </tr> <tr> <td>g.</td> <td>Journal bearing: Type / Size:</td> <td></td> <td>:</td> <td>*</td> </tr> <tr> <td>h.</td> <td>Thrust bearing: Type / Size:</td> <td></td> <td>:</td> <td>*</td> </tr> <tr> <td>i.</td> <td>Bearing cooling required</td> <td></td> <td>:</td> <td>Yes / No - Supplier to confirm</td> </tr> <tr> <td>j.</td> <td>Cooling water required</td> <td></td> <td>:</td> <td>Supplier to confirm the quantity</td> </tr> <tr> <td>k.</td> <td>Type of drive</td> <td></td> <td>:</td> <td>With Gearbox</td> </tr> <tr> <td>l.</td> <td>Shaft seal</td> <td></td> <td>:</td> <td>Mechanical</td> </tr> <tr> <td>m.</td> <td>Size / Code</td> <td></td> <td>:</td> <td>*</td> </tr> <tr> <td>n.</td> <td>Service factor</td> <td></td> <td>:</td> <td>*</td> </tr> <tr> <td>o.</td> <td>GD<sup>2</sup> at drive shaft end</td> <td></td> <td>:</td> <td>*</td> </tr> <tr> <td>p.</td> <td>Rotation viewed from coupling end</td> <td></td> <td>:</td> <td>Clock wise / Counter clock wise</td> </tr> <tr> <td>q.</td> <td>Total weight</td> <td>kg</td> <td>:</td> <td>*</td> </tr> <tr> <td>r.</td> <td>Maximum Erection weight</td> <td>kg</td> <td>:</td> <td>*</td> </tr> <tr> <td><b>6</b></td> <td colspan="5"><b>MATERIALS</b></td> </tr> <tr> <td>a.</td> <td>Casing</td> <td></td> <td>:</td> <td>*</td> </tr> <tr> <td>b.</td> <td>Impeller</td> <td></td> <td>:</td> <td>*</td> </tr> <tr> <td>c.</td> <td>Shaft</td> <td></td> <td>:</td> <td>*</td> </tr> <tr> <td>d.</td> <td>Shaft Seal</td> <td></td> <td>:</td> <td>*</td> </tr> <tr> <td>e.</td> <td>Base frame</td> <td></td> <td>:</td> <td>*</td> </tr> <tr> <td><b>7</b></td> <td colspan="5"><b>INSPECTION AND TESTING</b></td> </tr> <tr> <td>a.</td> <td>Material Test certificates required for : Casing, Impeller, shaft, shaft sleeve</td> <td></td> <td>:</td> <td>[R] [O]</td> </tr> <tr> <td>b.</td> <td>DPT &amp; MPI Test for impeller as applicable</td> <td></td> <td>:</td> <td>[R] [O]</td> </tr> <tr> <td>c.</td> <td>Ultrasonic &amp; Liquid penetrant test for shaft</td> <td></td> <td>:</td> <td>[R] [O]</td> </tr> <tr> <td>d.</td> <td>Dimensional &amp; visual inspection</td> <td></td> <td>:</td> <td>[R] [W]</td> </tr> <tr> <td>e.</td> <td>Mechanical running test for 4 hrs.</td> <td></td> <td>:</td> <td>[R] [W]</td> </tr> <tr> <td>f.</td> <td>Vibration test at rated speed</td> <td></td> <td>:</td> <td>[R] [W]</td> </tr> <tr> <td>g.</td> <td>Performance test</td> <td></td> <td>:</td> <td>[R] [W]</td> </tr> <tr> <td>h.</td> <td>Balancing test of Rotor Assembly</td> <td></td> <td>:</td> <td>[R] [O]</td> </tr> <tr> <td>i.</td> <td>Noise level test</td> <td></td> <td>:</td> <td>[R] [W]</td> </tr> <tr> <td>j.</td> <td>NPSH Test</td> <td></td> <td>:</td> <td>[R] [W]</td> </tr> <tr> <td>k.</td> <td>Hydrostatic Test</td> <td></td> <td>:</td> <td>[R] [W]</td> </tr> <tr> <td colspan="5">[R]: Required, [W]: Witnessed by BHEL/ end customer, [O]: Observed</td> </tr> </table>						d.	Discharge Rating / Size		:	*	e.	Type of rotor		:	*	f.	Size of rotor Dia	mm	:	*	g.	Journal bearing: Type / Size:		:	*	h.	Thrust bearing: Type / Size:		:	*	i.	Bearing cooling required		:	Yes / No - Supplier to confirm	j.	Cooling water required		:	Supplier to confirm the quantity	k.	Type of drive		:	With Gearbox	l.	Shaft seal		:	Mechanical	m.	Size / Code		:	*	n.	Service factor		:	*	o.	GD <sup>2</sup> at drive shaft end		:	*	p.	Rotation viewed from coupling end		:	Clock wise / Counter clock wise	q.	Total weight	kg	:	*	r.	Maximum Erection weight	kg	:	*	<b>6</b>	<b>MATERIALS</b>					a.	Casing		:	*	b.	Impeller		:	*	c.	Shaft		:	*	d.	Shaft Seal		:	*	e.	Base frame		:	*	<b>7</b>	<b>INSPECTION AND TESTING</b>					a.	Material Test certificates required for : Casing, Impeller, shaft, shaft sleeve		:	[R] [O]	b.	DPT & MPI Test for impeller as applicable		:	[R] [O]	c.	Ultrasonic & Liquid penetrant test for shaft		:	[R] [O]	d.	Dimensional & visual inspection		:	[R] [W]	e.	Mechanical running test for 4 hrs.		:	[R] [W]	f.	Vibration test at rated speed		:	[R] [W]	g.	Performance test		:	[R] [W]	h.	Balancing test of Rotor Assembly		:	[R] [O]	i.	Noise level test		:	[R] [W]	j.	NPSH Test		:	[R] [W]	k.	Hydrostatic Test		:	[R] [W]	[R]: Required, [W]: Witnessed by BHEL/ end customer, [O]: Observed				
d.	Discharge Rating / Size		:	*																																																																																																																																																																													
e.	Type of rotor		:	*																																																																																																																																																																													
f.	Size of rotor Dia	mm	:	*																																																																																																																																																																													
g.	Journal bearing: Type / Size:		:	*																																																																																																																																																																													
h.	Thrust bearing: Type / Size:		:	*																																																																																																																																																																													
i.	Bearing cooling required		:	Yes / No - Supplier to confirm																																																																																																																																																																													
j.	Cooling water required		:	Supplier to confirm the quantity																																																																																																																																																																													
k.	Type of drive		:	With Gearbox																																																																																																																																																																													
l.	Shaft seal		:	Mechanical																																																																																																																																																																													
m.	Size / Code		:	*																																																																																																																																																																													
n.	Service factor		:	*																																																																																																																																																																													
o.	GD <sup>2</sup> at drive shaft end		:	*																																																																																																																																																																													
p.	Rotation viewed from coupling end		:	Clock wise / Counter clock wise																																																																																																																																																																													
q.	Total weight	kg	:	*																																																																																																																																																																													
r.	Maximum Erection weight	kg	:	*																																																																																																																																																																													
<b>6</b>	<b>MATERIALS</b>																																																																																																																																																																																
a.	Casing		:	*																																																																																																																																																																													
b.	Impeller		:	*																																																																																																																																																																													
c.	Shaft		:	*																																																																																																																																																																													
d.	Shaft Seal		:	*																																																																																																																																																																													
e.	Base frame		:	*																																																																																																																																																																													
<b>7</b>	<b>INSPECTION AND TESTING</b>																																																																																																																																																																																
a.	Material Test certificates required for : Casing, Impeller, shaft, shaft sleeve		:	[R] [O]																																																																																																																																																																													
b.	DPT & MPI Test for impeller as applicable		:	[R] [O]																																																																																																																																																																													
c.	Ultrasonic & Liquid penetrant test for shaft		:	[R] [O]																																																																																																																																																																													
d.	Dimensional & visual inspection		:	[R] [W]																																																																																																																																																																													
e.	Mechanical running test for 4 hrs.		:	[R] [W]																																																																																																																																																																													
f.	Vibration test at rated speed		:	[R] [W]																																																																																																																																																																													
g.	Performance test		:	[R] [W]																																																																																																																																																																													
h.	Balancing test of Rotor Assembly		:	[R] [O]																																																																																																																																																																													
i.	Noise level test		:	[R] [W]																																																																																																																																																																													
j.	NPSH Test		:	[R] [W]																																																																																																																																																																													
k.	Hydrostatic Test		:	[R] [W]																																																																																																																																																																													
[R]: Required, [W]: Witnessed by BHEL/ end customer, [O]: Observed																																																																																																																																																																																	

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		SIGNATURE OF SUPPLIER -----		
		NAME -----		
		DESIGNATION -----		

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<div><div><div><b>COPYRIGHT AND CONFIDENTIAL</b> The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED. It must not be used directly or indirectly in any way detrimental to the interest of the company.</div><div>Ref Doc</div></div><div><b>22.2 Annexure-2, Schedule of guarantees</b><table><thead><tr><th>S.No</th><th>Description</th><th>Data</th></tr></thead><tbody><tr><td>1.</td><td>Rated capacity of pump m<sup>3</sup>/hr</td><td>:</td></tr><tr><td>2.</td><td>Total head at design capacity m</td><td>:</td></tr><tr><td>3.</td><td>Guaranteed shaft power consumption at rated capacity &amp; head kW</td><td>:</td></tr><tr><td>4.</td><td>Noise level at a distance of 1.0 meter from the equipment at site and 1.5 m above operating floor dB(A)</td><td>:</td></tr><tr><td>5.</td><td>Maximum vibration (peak to peak amplitude at site) microns</td><td>:</td></tr><tr><td>6.</td><td>Equipment Availability (%)</td><td>:</td></tr><tr><td>7.</td><td>Pump Efficiency (%)</td><td>:</td></tr><tr><td>8.</td><td>Life of Pump wear parts including, Casing liners, bearing etc Hours</td><td>: ≥25000 hours operation</td></tr><tr><td>9.</td><td>Scheduled Maintenance (Minor Overhauls): Recommended intervals between maintenance outages hours</td><td>: &gt;25000 hours operation.</td></tr><tr><td>10.</td><td>Scheduled Maintenance (Major Overhauls): Recommended intervals between maintenance outages shall be hours</td><td>: &gt;75000 hours operation.</td></tr></tbody></table></div></div> <div><div>SIGNATURE OF SUPPLIER</div><div>NAME</div><div>DESIGNATION</div></div>						S.No	Description	Data	1.	Rated capacity of pump m <sup>3</sup> /hr	:	2.	Total head at design capacity m	:	3.	Guaranteed shaft power consumption at rated capacity & head kW	:	4.	Noise level at a distance of 1.0 meter from the equipment at site and 1.5 m above operating floor dB(A)	:	5.	Maximum vibration (peak to peak amplitude at site) microns	:	6.	Equipment Availability (%)	:	7.	Pump Efficiency (%)	:	8.	Life of Pump wear parts including, Casing liners, bearing etc Hours	: ≥25000 hours operation	9.	Scheduled Maintenance (Minor Overhauls): Recommended intervals between maintenance outages hours	: >25000 hours operation.	10.	Scheduled Maintenance (Major Overhauls): Recommended intervals between maintenance outages shall be hours	: >75000 hours operation.
S.No	Description	Data																																				
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22.3 Annexure-3, Reference list (at least two power plant details)

S.No	Project Name , Customer & Plant capacity	Coal fired Yes/No	Wet Limestone Based FGD Yes/No	Model	Capacity m³/hr.	Head m	Speed rpm	Year of Commissioning	Qty
1									
2									
3									

SIGNATURE OF SUPPLIER

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22.4 Annexure-4, List of Deviations

S.No	Clause No	Page No	Description of Deviation

SIGNATURE OF SUPPLIER

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**22.5 Annexure-5**

**22.6.1 Documents to be submitted along with offer**

S.No.	Description	No of copies With proposal
1.	Duly signed Specification	1
2.	Price Sheet	1
3.	Anchor Plan & Civil foundation Loading details	1
4.	Data Sheet	1
5.	Performance curve, Motor T-S curve	1
6.	Pro-forma Packing List	1
7.	Manufacturing Time	1
8.	Approximate weight of each skid	1
9.	Reference plant details	1
10.	Required Electric power & other Utility List	1
11.	Deviation List	1
12.	General Assembly Drawing	1
13.	Pump Sizing Calculation	1
14.	Cross-sectional Drawing	1
15.	Sub-Vendor List	1
16.	Scope of Supply	1
17.	Quality Plan	1
18.	Spare List (Mandatory, Recommended)	1
19.	Start-up & Commissioning Spares	1
20.	List of Special Tools	1
21.	Delivery Schedule	1
22.	Test Arrangement & Test procedure	1
23.	Hoist/Crane requirement	1
24.	P & I Diagram	1
25.	Catalogue	1
26.		

SIGNATURE OF SUPPLIER \_\_\_\_\_


NAME \_\_\_\_\_

DESIGNATION \_\_\_\_\_

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**22.6.1 Documents to be submitted after award of contract**

S.No.	Description	No of copies After award of contract	Delivery Time
1.	Utility Consumption	1	2 weeks after contract
2.	Foundation Data including Anchor plan	1	2 weeks after contract
3.	Performance curve	2	2 weeks after contract
4.	General arrangement drawing	1	1 month after contract
5.	Cross section detail drawing	1	1 month after contract
6.	Data Sheet	1	2 weeks after contract
7.	Lubricating oil list	1	2 months after contract
8.	Special tools list	1	2 months after contract
9.	Installation and assembly procedure	1	4 months after contract
10.	Inspection and Test Procedure	1	1 month after contract
11.	Inspection & Test record	1	In 2 weeks after test
12.	Inspection Certificate	1	In 2 weeks after test
13.	Sub vendors List	1	2 weeks after contract
14.	Manufacturing Schedule	1	2 weeks after contract
15.	Progress report	1	Every month
16.	Pro-forma Packing List	1	2 months prior to shipping
17.	Approximate weight of pump	1	2 months after contract
18.	Required Electric power	2	2 weeks after contract
19.	Pump Sizing Calculation	1	2 weeks after contract
20.	Material Test Certificates	2	In 2 weeks after test
21.	Pre Commissioning Check List	2	4 months after contract
22.	Scope of Supply	2	2 weeks after contract
23.	Quality Plan	4	1 month after contract
24.	Operation and Maintenance Manual	Hardcopies and soft copies as mentioned	4 months after contract
25.	Spare List (Mandatory, Recommended)	1	1 month after contract
26.	Start-up & Commissioning Spares	2	1 month after contract
27.	List of Special Tools	1	1 month after contract

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S.No.	Description	No of copies After award of contract	Delivery Time
28.	Delivery Schedule	1	2 weeks after contract
29.	Test Arrangement & Test procedure	2	1 month after contract
30.	T-S curve	2	2 weeks after contract
31.	P & I Diagram	2	2 weeks after contract
32.	Catalogue	2	2 weeks after contract

SIGNATURE OF SUPPLIER \_\_\_\_\_

NAME \_\_\_\_\_

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**22.6 VENDORS' LIST**

**22.6.1 MECHANICAL SEAL**

1. EAGLE BURGMANN
2. FLOWSERVE SANMAR
3. JOHN CRANE SEALING SYSTEMS
4. NIPPON PILLAR
5. SEALMATIC INDIA



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