

	TECHNICAL SPECIFICATION OF AGITATORS
FGD:AGITATORS:REV01	

	BHARAT HEAVY ELECTRICALS LIMITED (A GOVT OF INDIA UNDERTAKING)	Flue Gas Desulphurization Group-FGD, Ranipet
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TECHNICAL SPECIFICATION OF AGITATORS

SPECIFICATION NO : FGD:AGITATORS
BUYER (EPC) : BHEL
APPLICATION : WET LIMESTONE FGD

01	09-09-2021	Generally Revised	<i>Jyotish Kumar Patel</i> Jyotish Kumar Patel	<i>S. Shanmuga Sundaram</i> Shanmuga Sundaram S	<i>V Kesavan</i> V Kesavan
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REV	Date	Description	Prepared	Checked	Approved

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I) DOCUMENTS TO BE SUBMITTED ALONG WITH THE OFFER:

Sl. No.	Description	Offer part	Purpose
1.	Documents for meeting the Pre-Qualification Requirement (3K format has to be submitted along with supporting documents)	Part -1	Qualification requirement for considering the offer
2.	Reference list – Annexure-I	Part -1	Qualification requirement for considering the offer
3.	Compliance to the technical specification (Complete Specification with Signature and Seal along with filled Annexures)	Part-1	Technical evaluation
4.	Data sheet of all Agitators (As per Annexure-II)	Part -1	Technical evaluation
5.	GA drawing, Exploded view with Material of construction, total weight of all Agitators models offered	Part -1	Technical evaluation
6.	Performance curve & TS curve of Agitators	Part -1	Technical evaluation
7.	GA drawing of Electrical motor & Data sheet and performance curves of all motors (As per Annexure-IV)	Part -1	Technical evaluation
8.	Schedule of Guarantees (Annexure-V) specific to the Enquiry	Part -1	Technical evaluation
9.	List of Deviations (Annexure-VI)	Part -1	Technical evaluation
10.	Mandatory Spare list	Part -1	Technical evaluation
11.	Agitator Motor Sizing Calculation (Annexure-III)	Part -1	Technical evaluation
12.	Motor vendor list and mechanical seal vendor list	Part -1	Technical evaluation
13.	Quality Plan	Part -1	Technical evaluation
14.	Start-up & Commissioning Spares	Part -1	Technical evaluation
15.	List of Special Tools	Part -1	Technical evaluation
16.	Catalogue	Part -1	Technical evaluation
17.	Priced offer	Part -2	Commercial evaluation

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II DOCUMENTS TO BE SUBMITTED AFTER CONTRACT:

Sl. No.	Description	Purpose	Delivery Time
1.	GA drawing, Exploded view, sectional view with Material of construction, mechanical seal , gearbox for all Agitator models	END CUSTOMER/BHEL approval to start manufacturing	2 week
2.	Data sheet for all Agitator	END CUSTOMER/BHEL approval to start	2 week
3.	Agitator Performance curve of all Agitators	END CUSTOMER/BHEL approval to start	2 week
4.	Electrical motor GA drawing & Data sheet and performance curves of all motors	END CUSTOMER/BHEL approval to start manufacturing	2 week
5.	Quality plan & Inspection and Test Procedure	END CUSTOMER/BHEL approval for inspection	2month after contract
6.	Agitator and Motor Sizing Calculation (Annexure-III)	END CUSTOMER/BHEL approval to start	2 week
7.	Bending moment calculation	END CUSTOMER/BHEL approval to start manufacturing	2 week
8.	Utility Consumption	To arrange utility	2 week
9.	Foundation Data including Anchor plan	To civil design	2 week
10.	Lubricating oil list	Record purpose	4 week
11.	Special tools list	For maintenance	4 week
12.	Installation and assembly procedure	For erection	4 week
13.	Approximate weight of each skid	To arrange lifting device	4 week
14.	Pre Commissioning Check List	For erection	4 week
15.	Operation and Maintenance Manual	For O&M	4 week
16.	Start-up & Commissioning Spares	For commissioning	4 week
17.	List of Special Tools	For arranging	4 week
18.	P & I Diagram (if applicable)	For information	4 week

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1.0 APPLICABLE CODES & REGULATIONS

The design and materials shall conform to the requirements of applicable codes and regulations of the latest edition. The design, manufacture, installation and testing of the Agitator shall follow the latest applicable Indian/International (AISI / ASME/EN/Japanese) Standards.

2.0 INTENT OF SPECIFICATION

This specification covers the minimum requirements for the complete design, material, manufacturing, shop inspection, testing at the manufacturer's works, supervision of erection & performance testing at bidder's works/ site of Agitators along with accessories which is furnished in the Flue Gas Desulphurization plant for END CUSTOMER Project. The following points have to be noted.

- a. Agitators are envisaged in various tanks, details of which are given in Technical Information of Agitators/Agitator Selection Criteria.
- b. Bidder shall assume full unit responsibility for the entire equipment assembly and make all possible efforts to comply strictly with the requirements of this specification and other specifications/attachments to inquiry/order.
- c. The Bidder shall offer only proven design which meets the Provenness /Pre-qualification requirement of END CUSTOMER. Necessary document evidences as per **Attachment-3K for qualification** shall be submitted along with the bid. If bidder doesn't meet the specified provenness criteria, their offer will be rejected.
- d. In case, deviations are considered essential by the Bidder (after exhausting all possible efforts), the same shall be separately listed in the Bidder's proposal under separate section, titled as "List of Deviations/Exceptions to the Enquiry Document (**ANNEXURE VI- LIST OF DEVIATIONS OR EXCEPTIONS TO THE ENQUIRY DOCUMENT**)
- e. Any deviation, not listed under the above section, even if reflected in any other portion of the proposal, shall not be considered applicable.
- f. No deviation or exception shall be permitted without the written approval of the purchaser.
- g. Compliance to this specification shall not relieve the Bidder of the responsibility of furnishing equipment and accessories/auxiliaries of proper design, materials and workmanship to meet the specified start up and operating conditions.
- h. In case, the Bidder considers requirement of additional instrumentation, controls, safety devices and any other accessories/auxiliaries essential for safe and satisfactory operation of the equipment, the same shall be recommended along with reasons in a separate section and include the same in scope of supply.
- i. All accessories, items of work, though not indicated but required to make the system complete for its safe, efficient, reliable and trouble free operation and maintenance shall also be in supplier's scope unless specifically excluded.

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3.0 PROVENNESS CRITERIA/Pre-QUALIFICATION REQUIREMENT:

The Bidders are required to meet the Qualification Requirement (PQR) for Agitators as per **Provenness Criteria & shall submit the credentials as called in Annexure-3K. Only OEMs qualifying as per the Qualification requirement shall be considered for placement order.**

4.0 POWER SUPPLY DETAILS:

	POWER SUPPLY	
	The following voltage levels shall apply:	
	3 phase, 3.3 kV AC ,50 Hz	Voltage for motors equal to / bigger than 200KW and for power distribution within the plant.
	3 phase, 415 V, AC , 50 Hz	Standard voltage for power supplies to electric power consumers and motors Above 0.2 KW and upto 200 kW.
	240V AC / 3 phase 415 V AC, 50 Hz	Standard voltage for power supplies to electric power consumers and motors Upto 0.2 kW.
	- All equipments shall be suitable for rated frequency of 50 Hz with a variation of + 3% & -5%, and 10 % combined variation of voltage and frequency unless specifically brought out in the specification. - Bidder shall design and supply the equipment suitable for satisfactory operation under above mentioned power supply condition.	

5.0 SCOPE OF SUPPLY

Scope for the bidders shall include Design, Manufacturing, Supply, and Supervision of Erection & Commissioning, Performance Testing at Site for satisfactory Performance

Design: Includes basic engineering, detail engineering, preparation and submission of engineering drawings/calculations/datasheets/quality assurance documents/field quality plans, storage instructions, commissioning procedures, operation & maintenance manuals, performance guarantee test procedures and assisting BHEL in obtaining time bound approval from END CUSTOMER.

Supply: Includes manufacturing/fabrication, shop floor testing, stage inspections, final inspections, painting & packing.

Supervision of Erection & commissioning: Includes supervision of erection & commissioning, supervision of trial operation, training of customer's O&M Personnel.

The scope of supply for AGITATORS shall include but not limited to the following:

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A) For Horizontal (Side Entry) Agitators:

Sl. No	Scope
1.	AGITATOR complete with
	i. AGITATOR Blades
	ii. AGITATOR Shafts
	iii. Coupling arrangement (Flexible)
	iv. Single Mechanical Seals
	v. Shaft Sleeve
	vi. Lanterns/ Stools (Bearing Housing), Safety Guard
	vii. Bearings
	viii. Agitator Mounting Flanges with gaskets and fasteners
	ix. Drive Motor(IE3) with gearbox / belt and pulley arrangement
	x. Supporting arrangement of Side Entry Agitator on the tank Wall.
	xi. Flushing system for start up consisting of Pipe with Flange . Gaskets and Fasteners to be provided for mounting the flush pipe on the Tank Nozzle
	xii. Foundation plate with foundation bolts
	xiii. Painting and Rust Prevention during shipment and construction
	xiv. Supervision of Erection & commissioning at site
	xv. Special tools & tackles as applicable
	xvi. Start-up and Commissioning Spares as applicable
	xvii. First fill Lubricants
	xviii. Installation, operation and maintenance manuals
	xix. Any other items required for completeness of the equipment except the items covered in the exclusions.

B) For Vertical (Top Entry) Agitators :

Sl. No	Scope
2.	AGITATOR complete with
	i. AGITATOR Blades
	ii. AGITATOR Shafts
	iii. Coupling arrangement (Flexible)
	iv. Gland Packing, Seals, O Rings, Glands
	v. Shaft Sleeve
	vi. Lanterns/ Stools (Bearing Housing), Safety Guard
	vii. Bearings
	viii. AGITATOR Mounting Flanges with gaskets and fasteners
	ix. Drive Motor(IE3) with gearbox/ belt and pulley arrangement
	x. Mating Flange for Supporting on Slurry Tank Roof
	xi. Painting and Rust Prevention during shipment and construction
	xii. Supervision of Erection & commissioning at site
	xiii. Special tools & tackles as applicable
	xiv. Start-up and Commissioning Spares as applicable
	xv. First fill Lubricants
	xvi. Installation, operation and maintenance manuals

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Sl. No	Scope
	xvii. Any other items required for completeness of the equipment except the items covered in the exclusions.

5.1	TECHNICAL REQUIREMENTS
1.	Agitators shall be supplied in tanks and vessels to prevent caking and settlement of particles out of the slurry, e.g. in the absorber vessel, limestone mill recycle tanks, limestone slurry tank, Auxiliary Absorbent tank, and sumps etc.
2.	All agitators shall be designed for continuous operation unless otherwise specified. The design of the agitators shall be of proven type. CFD analysis, if required, shall be provided during Offer stage or drawing approval stage at no extra cost.
3.	Standard type agitators with suitable characteristics shall be used wherever practical. The agitators shall be complete with motor, gearbox, agitator shaft, coupling, safety guards, mechanical seal (for side entry agitators), impeller, support legs, agitator mounting flange including bolts nuts and gasket etc.
4.	All agitator parts and accessories in contact with the stirred fluid shall be constructed of materials specifically designed for the conditions and nature of the stirred fluid and be resistant to erosion and corrosion.
5.	MOC of various agitator parts shall be as per "Technical Information of Agitators /Agitator selection Criteria" . This does not release the bidder of the responsibility for selecting the correct materials. All parts which are in contact with slurry or in contact with slurry fumes shall be considered as wetted part. The material selected shall be suitable to the service conditions.
6.	Each agitator and its associated equipment shall be arranged in such a manner as to permit easy access for operation, maintenance and agitator removal without interrupting plant operation. It shall be possible to remove the sealing devices of the absorber vessel without having to drain completely the absorber.
7.	To prevent mechanical blocking load start-up after standstill of pumps, piping and agitators for slurries shall be applied with C-hose connection.
8.	Lifting lugs and eyes and other special tackle shall be provided as necessary to permit easy handling of the agitators and their components.
9.	Static and dynamic (as far as applicable) balancing of all agitators shall be carried out after assembly.
10.	All agitator parts and components shall be designed and calculated for fatigue life, considering maximum bending loads, induced by fluctuating hydraulic forces and torsional loads, based on the installed motor power. For side entry agitators the alternating bending moment resulting from impeller and shaft weight has to be considered additionally.
11.	All exposed moving parts shall be covered by guards.
12.	The shape of the impeller blades of side entry agitators shall be designed to avoid wear on the impellers which will affect the agitator performance as specified for a minimum period of 2 years of continuous operation under design conditions for the range of coal & limestone specified in the specification. In order to avoid excessive wear impeller tip speeds must not exceed 12 m/s

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13.	Belt drives (if applied) shall be properly designed to provide a minimum lifetime of 2 years under design conditions	
14.	It shall be noted that all Agitators (except Absorber Agitator, Auxiliary Absorbent Tank Agitator and Drain Sump Agitator) are meant for keeping the solid particles in suspended mode in liquid with "Full Uniform Suspension" of solid particles to 98% of liquid column to virtually "Uniform Solid Concentration". No chemical reaction will take place.	
15.	For Absorber, Auxiliary Tank and Drain Sump Agitators : There shall not be any slurry settlement at the Bottom of the Tank and all solids shall be suspended off the tank bottom (i.e. Off Bottom suspension)	
16.	It is to be noted that in continuous process any deposit at tank bottom is the loss of material which are not getting converted as per process. Hence, total loss of material by sedimentation is a loss to FGD Process & determines the "In efficiency of the Agitator".	
17.	Vendor should ensure nil settlement; utilization of solid material shall be a guaranteed parameter and will be assessed in percentage (%) term to net wet of solid mass of inflow or out flow. This is one of the guarantee parameter.	
18.	Agitator and its driver shall perform on the test stand at shop and on the Agitator's permanent location at site within vibration limit the vibration of combined unit will be the responsibility of Agitator manufacturer. Agitator manufacturer is to ensure that Site performance of vibration is one of the "Acceptance Criteria" of the equipment. Please note vibration at test stand can only be taken as for information.	
19.	Impeller shall be kept above the sedimentation level of the tank (just 100-200mm above the sedimentation level).	
20.	Agitator must have low-pitch propeller with low solidity ratio and low Power Number. Power number shall 0.35 or lower. The Maximum Input Power at motor terminal shall be considered as a guaranteed parameter under "Schedule of Guaranteed Parameters" in "Annexure-V-Schedule of Guarantees"- and the same shall be calculated for maximum liquid level in tank. A calculation of power specifying the hydraulic power of Agitator, Seal loss, Gear box and Motor internal loss must be submitted along with the offer. A characteristics curve showing power versus liquid level should be submitted from the lowest liquid level, required for Agitator to maximum liquid level in the tank. Motor should be selected based on the highest power demand with a margin as per clause 5.3.1 at maximum liquid level, taking into account frequency variation.	
21.	Bidder shall provide the design and arrangement of baffle plates in circular tanks. Baffle plates are in BHEL scope.	
5.2	CONSTRUCTIONAL FEATURES	
A)	BLADE AND HUB OF PROPELLER	
i)	The type of impeller shall be selected on the basis of suspended solids where the work is being performed. The selected profile shall be consistent with the specified operating conditions ,i.e., the type of tank, solid concentration,etc.	
ii)	It must be possible to remove the blades from their joining point. Each blade shall be made of one single piece.	
iii)	The Blade design of the Agitator to be of most efficient design in order to offer least power consumption. The Agitator power consumption is part of the guarantee parameters.	
iv)	Although Agitator will have substantial low speed because of reduction Gear Box, hydraulic unbalance at impeller can cause severe vibration, hence it is mandatory that rotating assembly shall be dynamically balanced to its rated speed.	

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v)	Impeller should be dynamically balanced to Gr: G16: ISO-1940 after rubber lining of shaft (wherever applicable)	
vi)	For circular tanks with Top Entry agitator, the tip diameter of the impeller shall be one-third of the Tank diameter.	
vii)	For circular tanks with Top Entry agitator, Two level of impellers have to be offered for achieving uniform suspension if both the following conditions are satisfied: a) (Slurry Filling Height X specific gravity)/Tank Dia >1, b) (Slurry Filling Height X Specific Gravity)/ Impeller Tip Dia > 4. The tip diameter of both the impellers have to be same for maintaining uniform suspension(if uniform suspension is applicable). Bidder shall refer to the Technical Information of Agitator/Agitator Selection Criteria where two level of impellers are required for tanks with Uniform Suspension. However, bidder may propose two level of impellers for other tanks if their standard design permits the same.	
B)	SEAL	
1.	<u>Horizontal / Side Entry Agitators:</u>	
I.	Agitators should be provided with Single Stage mechanical seal. the mechanical seal should be as per ISO-21049 / API 682	
II.	The Mechanical Seals shall be so arranged that repacking or fitting of replacement seals can be carried out with the minimum of disruption to plant operation.	
III.	Design the mechanical seals chamber to have sufficient room to lubricate and get seal face cool with its own slurry.	
IV.	Provide requirements for periodical flushing to rinse the seal face for leaked slurry.	
V.	All mechanical seals, regardless of type or arrangement, shall be of the cartridge design. Hook sleeve cartridge should not be used.	
VI.	Requirement of flushing water, its quantity, and pressure to be indicated in data sheet.	
VII.	Zero leakage is the intension of this specification. However, quantity of leakage, if it is unavoidable, it should have a provision of collecting / or discharging back to the tank.	
VIII.	Mechanical seals shall be fitted and installed in the Agitator before shipment and shall be clean. Mechanical seals shall be plugged with screw for shipping.	
IX.	Intention of the specification is not to specify Type of Seal, Seal design, Spring configuration, Seal configuration, Balanced or Unbalance type etc. Agitator manufacturer to decide the same along with seal manufacturer the best seal that is suitable for the offered Agitator	
X.	Seal life has to be guaranteed, taking into consideration all its components for 20000 hrs. If the seals fail before the completion of guaranteed period, the same should be replaced free of cost by the bidder.	
XI.	The sub-vendor of the seal shall be approved by END CUSTOMER during contract execution.	

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2.	<u>Vertical Agitators for Other Slurry Tanks & Drain Pit Tanks</u>	
I	Agitator shall be supplied with stuffing box or Labyrinth seal or any proven equivalent or superior sealing type. Mechanical and hydraulic conditions in the seal chamber, required to maintain a stable film at seal face, including temperature, pressure and flow, shall be jointly established by Agitator manufacturer and seal manufacturer, and shall be noted in data sheet submitted in tender. If mechanical seal is offered by bidder, the mechanical seal should be as per ISO-21049 / API 682.	
C)	SHAFT	
	Use of dissimilar material at flange joint shall be avoided to eliminate any crevice corrosion. Spacing of the shaft joint should not be more than 3.0 m (preferably) for easy assembly if it is more than 40kg. If welding is used for joining two tubes, welding joint must be 100% radio graphed. If split shaft is proposed for larger tanks, shaft flange at the joining interface has to be rubber lined at manufacturer's works and necessary fasteners have to be provided. All the connecting fasteners shall be Alloy 926 or better material. All the Fasteners coming inside the tank (below the Mounting base or Mounting flange) shall be Alloy 926 or better material.	
D)	BEARING & BEARING HOUSING IN GEAR BOX	
	Bearing shall be of rolling type radial and thrust bearing (FAG/SKF make only) as required. Thrust bearing shall be sized for continuous operation under all specified condition.	
	Thrust bearing shall provide full load capability if the Agitator's normal direction of rotation is reversed. Up-thrust and Down-thrust load must be taken into account in sizing bearing. Life of every anti-friction bearing, used in the bearing housing as per manufacturer's design, should have L10 of 25000 hr (minimum).	
	None of the Shaft bearings shall be allowed to be inside the tank or drain.	
	Bearing housing should be grease/oil lubricated. If bearing is oil lubricated, constant-level sight-feed oiler of 100cc size or bigger capacity is to be provided. Bearing housing should have oil drain, constant oil level indicator. A provision of one(1) number G1/2" thread(ISO-228,Part-1)port is required for remote control of temperature of bearing housing oil bath RTD.	
	If bearing housing requires cooling water, volume and pressure of cooling water is to be indicated in Technical Data Sheet.	
	Lubricating oil will be the responsibility of Gear Box 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.	
E)	MATERIALS	
	Agitator components designated as "Full Compliance Material" shall meet the requirements of the industry specification as listed for the material in the table as well as in the specification in the respective section.	
	A detail quality plan is to be submitted along with offer for all items marked "Full Compliance Material".	
	Final acceptance of the quality plan will be approved by ultimate user (hereafter called END CUSTOMER). Hence, it is expected that manufacturer to submit quality	

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	plan (QAP) along with the offer. The same shall be followed at post order stage also. QAP should be as per the best practice followed internationally to avoid any conflict of interest.	
F)	Driver (Motor)	
1	Driver shall be sized to meet all specified operating conditions including bearing housing , seal, external gear box and coupling loss(if any).	
2	Motor shall be able to accelerate to speed at reduced voltage and frequency as specified in “Site Power Supply Condition” as per Clause: 4.1.	
3	It should meet Motor specification enclosed.	
G)	GEAR BOX	
	Gear box should be vertical flange mounted solid shaft type (Vertical Agitators), reducing speed type, specially designed for the requirement of Slurry mixing and to be manufactured by the Agitator supplier. Complete up-thrust and down-thrust, developed by Agitator shall be taken by thrust bearing housing of Gear Box. Gear Reducers shall confirm to AGMA standard as follows: A. 1.25 Service Factor based on Motor Horsepower B. 1.5 Service Factor based on calculated brake Horsepower	
H)	COUPLING & COUPLING GUARD	
I.	Coupling and coupling guard should be supplied between driver and driven equipment.	
II.	Coupling should be designed taking into consideration adequate service factor.	
III.	Design rating of the coupling (excluding service factor) should be indicated in data sheet.	
IV.	Coupling must be having locking screw so that it does not slide over shaft in due course operation.	
V.	Vertical Agitators - Coupling between Motor and Gear Box shall be Spacer-type flexible coupling, made of Cast Iron. Spacer length shall be of sufficient length so than Motor and Gear Box shall be able to run independently at no-load condition by detaching the respective coupling.	
VI.	It is desirable that for servicing of seal, coupling half should not be removed. Coupling should be dynamically balanced to Gr: G6.3, ISO-1940.	
VII.	Removable coupling guard shall conform to the requirements of all applicable national, industrial or statutory regulations.	
I)	PLATE AND FASTENING BOLTS	
I.	Base plate shall be interpreted as the component of Agitator assembly through which the whole load will be transmitted to the Sole Plate/Nozzle over which the equipment will be mounted. The Base plate shall be fabricated with mild steel of structural quality (UTS=42N/sq mm minimum) with anti-corrosive paint of sufficient dry-film thickness.	
II.	Base plate must have provision of leveling on its intended mounting place. Sole plate	

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	is not in the scope of supply of Agitator manufacturer. It should be noted that Sole plate will be rubber lined to prevent any leakage of corrosive gases	
III.	Alignment between Gear Head Shaft and Agitator shaft shall be within the permissible limit of Gear Box. Similarly, misalignment between Motor shaft and Gear Box Shaft shall be within 0.050 micron (radial) and 2 degree (angular) or better as per requirement of Motor and Gear Box	
IV.	Sole plate with desired number of hole, will be machined on one side. Sole Plate shall be welded to the structure after leveling, as recommended by Agitator manufacturer and rubber lining is completed before placing the equipment in its desired location.	
J)	OTHER COMPONENTS	
	All fasteners used in wetted condition must be of Nickel alloy material or better material (bidder shall refer to the Technical Information of Agitators/Agitator Selection Criteria for details regarding the MOC of Wetted Fasteners) so that even if it comes in contact with liquid by swelling of rubber, thread remains unaffected. All fasteners provided inside the tank (even if it is exposed to the slurry vapour) shall be treated as wetted part only. Raw material of fastener must undergo Inter-granular Corrosion test as per ISO-3651, Part-1 for Nitric Acid test.	
	GENERAL REQUIREMENT OF SIDE ENTRY AGITATORS:	
I.	All Agitators shall be designed for continuous operation.	
II.	The Material of Construction (MOC) of side entry Agitators shall be as per "Technical Information for Agitator/Agitator Selection Data" enclosed.	
III.	It should be of Flange mounted type.	
IV.	Nozzle, on which Agitator shall be mounted, shall have enough opening to Insert rotating assembly from side. Vendor to suggest the nozzle size . Purchaser will provide the Nozzle based on Vendor's recommendation.	
V.	Bidder shall consider Gypsum Sedimentation during stoppage of Agitator.	
VI.	<u>The following information to be provided along with the bid:</u> <u>Impeller Diameter</u> <u>Impeller Speed</u> <u>Agitator Pumping Capacity (m³/min)</u> <u>Volume per Agitator:</u>	
	<u>TOP ENTRY AGITATORS IN OTHER SLURRY TANKS & DRAIN PITS:</u>	
I.	All Agitators shall be designed for continuous operation.	
II.	The Material of Construction (MOC) of Top Entry Agitators shall be as per "Technical Information for Agitator/Agitator Selection Data" enclosed.	
III.	It should be roof mounted.	

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IV.	Agitators shall be vertical mounted type and shall be driven by motor with reducing speed gear box of rigid type, solid shaft coupling between gear box and agitator and flexible coupling of spacer type coupling between Motor and Gear Box. Both Gear Box and Motor should be vertically/horizontally flange mounted type with a common frame of the whole equipment. The entire thrust load of agitator should be transmitted to the thrust bearing of Gear box.	
V.	Cable entry to the Motor terminal box should preferably be from top when motor is vertically mounted at its position and it should be easily accessible.	
VI.	Nozzle, on which Agitator shall be mounted, shall have enough opening to Insert rotating assembly from top.	
VII.	Impeller should be dynamically balanced to Gr: G16: ISO-1940 after rubber lining of shaft.	

5.3 MOTOR

➤ **Degree of Protection**

Degree of protection for various enclosures shall be as follows:

- a) Outdoor motors : IP 55
- b) Cable box-Outdoor area : IP 55

➤ **Codes and Standards**

- a) Three phase induction motors : IS325
- b) Single phase AC : IEC 60034

➤ **Painting**

Paint shade shall be as per RAL5012

Motors shall be of IE3 energy efficient class. The Motor speed shall be **1500 rpm or less**.

AC Motors:

All AC motor shall be Squirrel cage induction motor and, shall be suitable for direct –on-line starting. Rating of the motor should of Type S1 (Continuously rated) as per ISO-60034, Part-

1. Rating of motor must be at least 1.2 times the maximum power demand of the driven equipment.

Bidder shall refer to the detailed LT Motor Specification enclosed.

6.0 GENERAL REQUIREMENTS:

S.No	Description
1.	Metric unit shall be used in the drawings and in the any displays on the equipment's. Special attention should be taken that the unit of pressure shall be in dual scales of kPa and kg/cm ² G. For instance the pressure gauges should have dual unit's indication.

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S.No	Description
2.	Descriptions in the drawings, in the documents, and in the displays shall be in English
3.	All rotating parts such as coupling shall be covered with suitable protective guards. Guards shall be easily removable type.
4.	The equipment shall be designed to withstand the corrosive and moist environment in which these are proposed to operate.
5.	Noise level produced by any rotating equipment individually or collectively 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.
6.	The overall vibration level shall be as per ISO 10816.
7.	Suitable drain connections shall be provided.
8.	The equipment shall be suitable for stable operation continuously.
9.	Corrosion allowance: Corrosion allowance for entire equipment shall be in accordance with latest applicable Indian / International standard.
10.	Unless otherwise specified , flanges shall be in accordance with ANSI B16.5 Class 150
11.	Name plate: All equipment shall be provided with nameplates indicating the item number and service name. Name plates shall be of 304 Stainless steel plate and placed at a readily visible location. Nameplate of main equipment shall have enough information, which will be confirmed during engineering phase. Stainless steel nameplates for all instruments and valves shall be provided.
12.	Rotation arrows shall be cast in or attached with stainless steel plate on each item of rotation equipment at a readily visible location.
13.	Unless otherwise specified, all equipment items where the weight exceeds 15 kg shall be provided with suitable lifting lugs, ears or ring bolts or tapped holes for lifting rings. Minimum shock factor for lifting lugs shall be minimum 2.0. The position of lifting lugs and reference dimension shall be shown on GA and/or outline drawings. NDT shall be conducted for lifting lugs. When any spreader bars are required for lifting and laydown, the bidder shall provide spreader bar with equipment.
14.	Skid Mount/Transportation: Equipment shall be fabricated as skid mount design as much as practical to minimize erection at the site.
15.	If the driver/driven equipment train is in the resonance condition or any vibration problems occur, the bidder shall solve the problems in a timely manner.
16.	Bidder shall provide the necessary gaskets.
17.	All the surfaces of the carbon steel should be rust prevented before shipment for the period of at least 12 months for storage and construction.
18.	Bidder to provide capacity of crane or hoist required for material handling and the details of heaviest component to be handled.

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19.	The list of all Bought out items with makes and country of origin to be mentioned along with offer to be submitted.
20.	Quality Plan to be submitted along with the offer.
21.	Cost towards the participation in discussions/meetings, providing technical assistance during technical discussions/meetings with customer for approval of drawing/documents etc. TA/DA, boarding and lodging to attend these meetings shall be borne by the bidder and shall be inclusive in supply portion.
22.	Material of construction for all equipment/components shall be subject to END CUSTOMER/ BHEL approval during detail engineering. Accordingly bidder shall consider MOC for all equipment/component as per best engineering practice, global standard and global references.
23.	Bidder to provide sub vendor list and Bidder shall strictly adhere to END CUSTOMER approved vendor list. In case bidder proposes an additional vendor for an item or vendor approval is required for any new item, acceptance shall be subject to approval by END CUSTOMER/ BHEL before placing order and bidder shall submit relevant documents to take up with END CUSTOMER for approval.
24.	It shall be the complete responsibility of the successful bidders to obtain "Sub Vendor Approval" from BHEL / END CUSTOMER for all equipment's & components. Any delay in sub vendor's approval should not affect the project schedule. If any of the sub vendors does not have the approval of END CUSTOMER/ BHEL, the same may be replaced with another END CUSTOMER/BHEL approved sub-vendor only, without any price implications to BHEL.
25.	The modalities of inspection (Stage, Final, In-process) shall be finalized during detail engineering after submission of quality assurance plan (QAP). It shall be reviewed by the END CUSTOMER and BHEL. Bidder shall follow the procedures of inspection as per the approved QAP. Bidder has to submit the following documents along with inspection call and if any other documents required as per approved QAP. - Raw material inspection certificate - Internal test reports - Statutory certificates as required. - All inspection & testing shall be carried out based on the following documents: b. Relevant Standards c. Specifications d. Approved drawings e. Data Sheets f. Calibration certificate for all the measuring instruments g. Bidder should also coordinate in getting the MDCC's (Material Dispatch clearance certificate) and all types of IC's (Inspection Certificates) from the END CUSTOMER along with BHEL.
26.	During detail engineering, bidder to strictly adhere to BHEL/END CUSTOMER drawing formats, document numbering, quality plan & FQP formats

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27.	The identification and numbering of equipment, systems, items, etc. of supply, as well as of all documents and drawings shall be in accordance with reference Designation System for Power Plants - KKS system.
28.	Complete detail engineering drawings, calculations, selection of components etc. shall be reviewed & subject to approval of BHEL/END CUSTOMER during detail engineering
29.	Bidder shall furnish necessary inputs & drawings of all equipment in editable Auto CAD/ MS-Word /Excel format.
30.	During detail engineering, successful bidder shall ensure flow of drawings/documents as per schedule. Any comments from BHEL/END CUSTOMER should be addressed timely by the bidder.
31.	Bidder to note that list above is not exhaustive and any work /items required for completing the smooth operation and ensuring satisfactory running of the machines till final hand over to the end user shall also be in the scope of the bidder.
32.	Bidder 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 & the scope division along with technical offer. a. "Accepted without deviation and considered in scope of work" b. "Not considered in scope of work"
7.0	PACKING AND FORWARDING
1.	Proper packing to be ensured. Indigenous Supply: Agitator & sub system assembly shall be wrapped in polythene bags & packed in a strong rigid wooden crate. Rain water should not enter into the Agitator internals during storage in the outer yard of power plant. Imported Supply: All imported supply should be packed as per Sea worthy packing standards PE-TS-888-100-A001. All imported items should have Sea worthy packing. Liberal packing materials and struts shall be provided to arrest rolling and to protect from transit damages.
2.	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.
3.	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.
4.	Crates and packing material used for shipping will become the property of owner.(END CUSTOMER)

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5.	Packaging or shipping units shall be designed within the limitations of the unloading facilities of the receiving ports and the ship will be used. It shall be the bidder's responsibility to investigate these limitations and to provide suitable packaging and shipping to permit transportation to site.
6.	Packing (tare) shall be part of the equipment cost and shall not be subject to return. The packing should ensure integrity and cohesiveness of each delivery batch of equipment during transportation. In case of equipment assemblies and unit's delivery in the packing of glass, plastics or paper the specification of packing with the material and weight characteristics are to be indicated.
7.	Each package should have the following inscriptions and signs stenciled with an indelible ink legibly and clearly: a. Destination b. Package Number c. Gross and Net Weight d. Dimensions e. Lifting places f. Handling marks and the following delivery marking
8.	Each package or shipping units shall be clearly marked or stenciled on at least two sides as per the dispatch instruction givens during the contract: In addition, each package or shipping unit shall have the symbol painted in red on at least two sides of the package, covering one fourth of the area of the side.
9.	Each part of the equipment which is to be shipped as a separate piece or smaller parts packed within the same case shall be legibly marked to show the unit of which it is part, and match marked to show its relative position in the unit, to facilitate assembly in the field. Unit marks and match marks shall be made with steel stamps and with paint.
10.	Each case shall contain a packing list showing the detailed contents of the package. When any technical documents are supplied together with the shipment of materials no single package shall contain more than one set of such documents. Shipping papers shall clearly indicate in which packages the technical documents are contained.
11.	The case number shall be written in the form of a fraction, the numerator of which is the serial number of the case and the denominator the total number of case in which a complete unit of equipment is packed.
12.	Wherever necessary besides usual inscriptions the cases shall bear special indication such as "Top", "Do not turn over", "Care", "Keep Dry" etc. as well as indication of the center of gravity (with red vertical lines) and places for attaching slings (with chain marks)
13.	Marking for Safe handling: To ensure safe handling, packing case shall be marked to show the following: a. Upright position b. Sling position and center of Gravity position

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	c. Storage category d. Fragile components (to be marked properly with a clear warning for safe handling)
14.	Each crate or package is to contain a packing list in a waterproof envelope. All items are to be clearly marked for easy identification against the packing List. All cases, packages etc. are to be clearly marked on the outside to indicate the total weight where the weight is bearing and the correct position of the slings are to bear an identification mark relating them to the appropriate shipping documents. All stencil marks on the outside of cases are either to be made in waterproof material or protected by shellac or varnish to prevent obliteration in transit.
15.	The packing slip shall contain the following information: - Customer name, Name of the equipment, Purchase Order number with Date, Address of the delivery site, Name and Address of the Sender, Serial Number of Agitator, BHEL item Code, Gross Weight and Net weight of Supplied items.
16.	Prior to transport from manufacturer's work to destination, components of the unit shall be completely cleaned to remove any foreign particles. Flange faces and other machined surfaces shall be protected by an easily removable rust preventive coating followed by suitable wrapping.
17.	All necessary painting, corrosion protection & preservation measures shall be taken as specified in painting schedule. Supplier shall consider the coastal environment zone which is defined as "very severe" during final finishing/shipping.
18.	Successful bidder shall furnish the detail packing /shipment box details with information like packing box size, type of packing, weight of each consignment, sequence no. of dispatch, no. of consignment for each deliverable item against each billing break up units/ billable blocks. Without these details the BBU shall not be approved during detail engineering. Also, complete billing break-up with above mentioned details shall be submitted within 10days of LOI.
19.	All items/equipment shall be dispatched in properly packed condition (i.e. no item shall be dispatched in loose condition such that it becomes difficult to store/identify its location at site at a later stage).
20.	Cases which cannot be marked as above shall have metal tags with the necessary markings on them. The metal tags shall be securely attached to the packages with strong steel binding wire. Each piece, Skid, Case or package shipped separately shall be labelled or tagged properly.
8.0	SUPERVISION OF ERECTION, TESTING AND COMMISSIONING
1.	The erection of Agitators will be done by owner as per Erection Manual and check List. However, the bidder shall make visit as per enquiry/PO for the supervision of erection, pre-commissioning & post- commissioning check-up, start-up, testing and trial runs of all the items covered under the scope of supply.
2.	The bidder will be informed well in advance for the visit.
3.	All TA/DA, Site Expenses, Travel charges boarding and lodging shall be borne by the bidder and shall be inclusive in supervision portion.

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4.	Price comparison for evaluating the lowest bid will be considered all main supply, supervision of E&C charges and mandatory spares price all together.
9.0	EXCLUSION
	The following work associated with the Agitators will be by others: - Walkways, platforms and ladders - Element handling hoists.
10.0	INSPECTION AND TESTING
1.	The General inspection requirements to be considered are as below:
	Test in the Workshop:
	a) Once the manufacturing process is completed, and before the material is sent to site, the Successful bidder must conduct in his own facilities or other certified facilities , all the test that are listed in this section. The successful bidder shall specify whether or not he possesses suitable facilities and installations for conducting the test on the items of equipment that are the subject of the bid.
	b) The Suppliers' standard test shall be conducted in the workshop on all the Motors, Reducers and items of the Transmission equipment.
	c) The mechanical locks shall be checked on the bed to ensure that they have the design differential pressure And design speed.
	d) All the shafts shall be ultrasonically tested.
	e) In the event there being elements or components that are stuck together, the adherence , hardness , lack of porosity shall be checked.
	f) An operating test shall be conducted in the workshop on every type of agitator model, with a view of verifying that the operating parameters comply with the guarantee parameters. The Bidder shall furnish performance test procedure along with standard. The test procedure will be reviewed and approved by the BHEL/END CUSTOMER
2.	Since there is no standard for "Acceptance Test Procedure" for Agitator, Agitator manufacturer is to submit a test procedure and Quality Plan, clearly indicating that equipment will meet the desired parameter.
3.	Power consumption at motor terminal and vibration of equipment will be conducted at site. Vendor to indicate other material tests that are to be conducted as per their practice in their Quality plan.
4.	No liquid should enter the tube through any flange joint. "O"-ring used in the flange joint will deteriorate at a highly chlorinated and acidic environment of medium at a maximum operating temperature unless right quality of rubber is used. Hydrostatic testing of tube assembly is required at a pressure of twice that of maximum liquid column in any tank or 30m whichever is higher. The hydro test duration will be for a minimum of 1 hr to check sweating at any flange. Hydrostatic test is meant in part for a check of equipment joint at new condition only. It cannot be considered as a

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	guarantee of functional objective of rubber used.
5.	DYNAMICS
	5.1 :CRITICAL SPEED
	Operation speed of the Agitator motor shall be at least 25% below the first critical speed
	Additional to the requirement of the critical speed of Agitator, as specified above. Agitator manufacturer is to analyze the torsional critical speed of combined system of Agitator, Gear Box and Motor to establish that the torsional critical speed is well off the operating speed by 20% from the operating speed.
	5.2 : VIBRATION SEVERITY
	During performance test, unfiltered vibration measurements shall be made with running of Agitator in Air. Measurement shall be taken on the Gear Box thrust bearing housings as well in motor top.
	Guaranteed Site vibration of the equipment on its own pedestal, at commissioning with normal level of liquid and with maximum liquid at respective tank, Vibration limit at site will be as per ISO-10816, even if Motor rating falls below 15kw.
	Vibration measurements of bearing housing shall be made in root mean square (RMS) velocity.
	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.
	6. 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.
	7. 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.
	8. Test certificates shall be issued for each lot of raw material used in the coating, corresponding to specific weight and traction resistance.
	9. 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.
	10 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.
11	Out of all Agitators, One Number of each type will be inspected by the Purchaser at the Bidder's

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	works before dispatch or where the test facilities are available.
12	However, the Bidder shall conduct performance test for the remaining Agitators and submit the reports.
13	Contract shaft mechanical seals shall be used during shop tests, unless the seal design is unsuitable for the shop-test condition, if applicable.
14	Agitators shall not be released for shipment, until shop tests data and performance tests curves have been approved by Owner.
15	Bidder should furnish performance guarantee as per applicable standard guarantee for the design, manufacture, material and safe operation of the equipments.
16	BHEL shall witness the test at Bidder's works and a notice of minimum three (3) weeks shall be given for attending the inspection.
17	Bidder to arrange all calibrated gauges, Instruments during inspection.
11.0	PAINTING
1.	Painting details :- Agitators shall be painted as per the painting scheme which will furnished to the Successful Bidder during contract stage. The Total DFT will be maximum 300 micron
2.	Rust preventive paint after inspection at shop floor before dispatch shall be in bidder's scope
3.	Corrosion protection, coating and galvanizing, painting shall be taken care by the bidder. Bidder shall follow the painting scheme which will be furnished by the Purchase during contract stage.
12.0	SPARES,TOOLS & TACKLES
	Any special tools & tackles required for the entire equipment to disassemble, assemble or maintain the units, they 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 bidder as per his proven practice. When special tools are provided, they shall be packaged in separate, boxes with lugs and marked as "Special Tools for (tag / item number)." Each tool shall be stamped or tagged to indicate its intended usage. Levers and eye bolts for the removal of parts to be serviced shall be submitted with special tools.
12.1	START UP & COMMISSIONING SPARES
	Start-up & Commissioning Spares shall be part of the main supply of the Agitators. Start-up & commissioning spares are those spares which may be required during the start- up and commissioning of the equipment/system. All spares required for successful operation till commissioning of Agitator shall come under this category. Bidder shall provide an adequate stock of such start up and commissioning spares to be brought by him to the site for the equipment erection and commissioning. The spares must be available at site before the equipment's are

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	energized. The List of such spares to be provided during bidding stage. Bidder shall consider and supply all the spares required for the operation of the equipment within the warranty or guarantee period.
12.2	RECOMMENDED SPARES
	Bidders shall also furnish the recommended spares list along with the offer required for 3 years of normal operation of the plant and should be independent of the list of the mandatory spares. Prices of recommended spares will not be used for evaluation of the bids. The price of these spares will remain valid up to 6 months after placement of Notification of Award for the main equipment
12.3	MANDATORY SPARES:
	Bidder to quote for the mandatory spares as per the Mandatory Spare list enclosed. The mandatory spares will be considered for L1 evaluation. Mandatory spare parts items shall be handed over separately and shall not be mixed with the supply of the main equipment parts. Spares shall be sent in pre-decided lots in containers/secure boxes. All boxes/containers are to be distinctly marked in red color with boldly written "S" mark on each face of the containers. Spares shall not be dispatched before dispatch of corresponding main equipment's. Each item shall be labelled in English and be packed against damage and sealed to prevent deterioration from corrosion. The protection shall be sufficient for a minimum of 10 years' storage in a dry weatherproof building. All spares supplied under this contract shall be strictly inter-changeable with the parts for which they are intended for replacements. All the Mandatory spare s shall be manufactures along with the main equipment components as a continuous operation as per same specification and quality plan. Any special tools & tackles required for the entire equipment to disassemble, assemble or maintain the units, they 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 bidder as per his proven practice. When special tools are provided, they shall be packaged in separate, boxes with lugs and marked as "Special Tools for (tag / item number)." Each tool shall be stamped or tagged to indicate its intended usage. Levers and eye bolts for the removal of parts to be serviced shall be submitted with special tools.
13.0	PERFORMANCE GUARANTEE
	- All performance tests for Agitators shall be carried out in accordance with any latest international codes/standards. - Bidder shall furnish Performance guarantee for the design, manufacture, material, safe and trouble-free operation of the Agitators and its accessories - The Bidder shall ensure a design of the equipment to achieve an average target availability of 98% for 120 days and average target availability of 95% for 1 year. - Noise level ≤ 85 dB (A) at 1m horizontal distance from equipment/enclosures and 1.5m above operating floor is to be guaranteed.

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	e) 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. f) Acceptance tests to be carried out as per the procedure defined by the bidder which shall be submitted for BHEL/ END CUSTOMER approval. g) In the event that the performance test is unsuccessful, bidder shall take necessary remedial action at his cost and the performance test shall be repeated.
14.0	BID EVALUATION CRITERIA FOR POWER CONSUMPTION:
1.	POWER GUARANTEE Bidder to specify the total guaranteed power per Agitators (i.e. power consumed at Motor input terminal at normal liquid level) operating at the rated capacity in their offer.
2.	BID EVALUATION CRITERIA FOR POWER CONSUMPTION: Only agitators which are in continuous operation will be considered for power consumption. The best of the parameter for auxiliary power consumption quoted by any qualified bidder shall be taken as the base or ceiling value. Bid prices of other bidders will be loaded for every KW excess over the ceiling value as per the formula given below. Adjustment factor for excess power consumption = $(GPC-BV) \times PL \times \text{No's of Working Agitators}$ GPC- Guaranteed Power Consumption at the Motor Terminal at the Normal Liquid level quoted by bidder in KW BV- Base Value (Bidder shall refer to the Technical Information or Agitator Selection Document) PL- Power Loading per KW . (Bidder shall refer to the Technical Information or Agitator Selection Document) However, the maximum value of power loading will be limited to 10% of the equipment value.
15.0	LIQUIDATED DAMAGES FOR POWER CONSUMPTION
	If actual Power Consumption during prove out (or) PG Test operating at the duty point exceeds the value guaranteed by the bidder, liquidated damages for shortfall in performance shall be deducted from contract price as per the formula given below Liquidated damage deductible = $(APC-GPC) \times P \times \text{Total no of Working agitators}$ Where GPC- Guaranteed Power Consumption at the Motor Terminal at the Normal Liquid level quoted by bidder in KW APC- Actual Power Consumption in KW N- Total Number of Agitators P- Penalty per KW (Bidder shall refer to the Technical Information or Agitator Selection Document)

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	Note : 1. LD will be levied after conducting performance test as above subjected to the maximum 10% of the main equipment value. LD will be adjusted from the pending bills payable to the bidder. 2. For conducting PG test at project site for demonstrating the guaranteed parameters of Agitator, vendor has to make own arrangement. TA/DA , Stay , Travel charges shall be borne by the Bidder and charges towards the same shall be considered suitably in their Offer.
16.0	WARRANTY/DEFECT LIABILITY
1.	The Bidder warrants that the equipment's/items shall be free from defects in the design, engineering, materials and workmanship of the Plant and Equipment supplied and of the work executed. The Warranty Period shall be thirty six months (36) months from the date of Supply or twenty four (24) months from the date of commissioning, whichever first occurs. If during the Warranty/Defect Liability Period any defect should be found in the design, engineering, materials and workmanship of the Plant and Equipment supplied or of the work executed by the Bidder, the Bidder shall promptly, in consultation and agreement with BHEL regarding appropriate remedying of the defects, and at its cost, repair, replace or otherwise make good (as the Bidder shall, at its discretion, determine) such defect as well as any damage to the Facilities caused by such defect.
2.	In case of failure of the equipment to meet the guarantee, END CUSTOMER/BHEL reserves the right to reject the equipment. However, END CUSTOMER/BHEL reserves the right to use the equipment until new equipment supplied by bidder meets the guaranteed requirement .
17.0	FIRST FILL OF CONSUMABLES:
1.	Bidder's scope shall also include supply and filling of all chemicals, reagents, resins, lubricants, grease, filters and consumable items for operation up to commissioning including top up requirements upto the warranty or guarantee period. 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.
2.	Detailed specifications for the lubricating oil, grease, gases, servo fluids, control fluids, chemicals including items qualities and quantities required per month of the plant operation for the END CUSTOMER/BHEL's approval herein shall be furnished within 2 months of placement of Order. On completion of erection complete list of bearings/equipment giving their location and identification marks shall be furnished to BHEL along with lubrication requirements. All types of consumables, lubricants and grease shall be readily obtainable locally and the number of different types shall be kept to a minimum. For each type and grade of lubricant recommended, bidder shall list at least three equivalent lubricants manufactured by alternative companies.
18.0	TRAINING
	Successful bidder shall provide comprehensive training for END CUSTOMER/BHEL Engineering, O&M, Erection & Commissioning staffs at site covering all aspects of the Agitators - Operation & Maintenance, Troubleshooting etc.

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S.No	Description
19.0	CONFLICT
	Bidder's equipment shall be designed for and shall meet the service, performance and minimum level of quality requirements specified. Bidder shall be solely responsible for advising END CUSTOMER in writing of any conflicts between the specifications and Bidder's design, including performance and levels of quality. Bidder agrees that its obligations, liabilities and warranties shall not be diminished or extinguished due to its meeting the requirements of the Specification.
20.0	DOCUMENTATION
A	DOCUMENTS TO BE SUBMITTED ALONG WITH THE OFFER
	The Bidder shall submit all documents, drawings, diagrams and all such information, which are necessary to fully understand the offer for techno – commercial Offer. Vendors are requested to comply with above in all respect.
B	DOCUMENTS TO BE SUBMITTED AFTER AWARD OF CONTRACT
	The Successful bidder shall submit necessary data, documents and drawings for review, approval as specified in this specification. Drawings that are reviewed by the END CUSTOMER/ BHEL will be returned to bidder with a transmittal letter with any comments and / or questions marked on the drawings or noted in the letter. All comments and questions must be resolved before a resubmission of drawings / documents. If the design has not developed enough to resolve some of the comments or questions, bidder shall place a "hold" on those items or areas of design. END CUSTOMER/ BHEL reserves the right to return drawings unprocessed to bidder if there exists any evidence that bidder has not acknowledged all comments and questions. All necessary GA drawings, sections, sub-assembly drawings, specifications of main and sub components and necessary set of operation & maintenance manual as asked by END CUSTOMER must be furnished by bidder in soft and hard copy forms. For all documents softcopy format shall be searchable pdf, however in addition all drawings, diagrams shall be supplied in ACAD or other editable format and all lists in Excel format. Further break up of technical documents will be discussed during finalization of the purchase contract. Unless agreed otherwise, Ten (10) hard copies and five (05) sets of electronic copies of all documents are to be submitted in the English language. Electronic Copies shall be submitted in primary original data format (e.g. DOC, XLS, DWG) as well as in a printable non-proprietary document format (e.g. PDF). Especially P&IDs shall be submitted as DWG files and PDF files. Bidder to ensure submission of hard copies as per END CUSTOMER requirement for all engineering drg/doc and for all subsequent revisions along with a soft copy through email to concerned project team.

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ANNEXURE-I – REFERENCE LIST

Project :

Enquiry No :

REFERENCE LIST as per format shown below. (Reference plant details for Horizontal and Vertical Agitators)

S.No	Project Name , Customer & Plant capacity	Coal fired Yes/No	Wet Limest one Based FGD Yes/No	Model	Size of Tank	Type / Hor / Vertical	Speed rpm	Year of Commg	Qty

Note :

Bidders shall also submit reference list of Horizontal /Vertical agitators as per the format given above.

BIDDER SIGN : _____

DESIGNATION : _____

DATE : _____

BIDDER SIGN WITH SEAL AND DATE:

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Annexure-II TECHNICAL DATASHEET OF AGITATORS (TO BE FILLED FOR EACH AGITATOR)

Project :

Enquiry No :

Sl.no	General	Units	DATA
1.1	Project		
1.2	Ultimate Customer		
1.3	Location		
1.4	Order Number/Enquiry No		
1.5	Agitator Name		
1.6	Service		
1.7	Installation		
1.8	No. of Agitator per Tank		
1.9	Total No's of Agitator for all the units		
1.10	Type of Agitator		TOP ENTRY/SIDE ENTRY
1.11	Model Number		
1.12	No of Stage(No of propeller per Agitator)		
1.13	Mounting of Agitator		
1.14	Mounting of Gear Head		
1.15	Mounting of Motor		
2	Performance Details		
a.	Input power at Motor terminal at highest frequency and Maximum liquid level in tank	KW	
b.	Input power at Motor terminal at Normal frequency (50Hz) and Normal liquid level in tank	KW	
c.	Motor rating	KW	
d.	Rated speed	rpm	
e.	Critical Speed	rpm	
f.	Tip speed	m/s	
g.	Direction of rotation of Motor and Gear box viewed from Motor non-driving end		
h.	Direction of rotation of Agitator viewed from Gear head end		
i.	Minimum submergence required over blade centre line for continuous operation	mm	

		TECHNICAL SPECIFICATION OF AGITATORS		REF: FGD:AGITATORS
				REV. No. 01
j,	Impeller diameter	mm		
k.	Minimum clearance required below impeller centre line	mm		
l.	Maximum liquid level over propeller centre line up to which Agitator can work without overloading of motor at 50Hz	mm		
3	Construction Features			
3.1	Impeller			
	a) Type			
	b) Diameter(tip to tip)	mm		
	c) Hub diameter	mm		
	d) No of blade per Impeller			
	e) Thickness of blade	mm		
3.2	Tube thickness, if any	mm		
3.3	Shaft diameter at coupling (GH-Agitator)	mm		
3.4	Length of Top shaft	mm		
3.5	Connection Details			
	· Blade to Hub:			
	· Hub to Shaft/Tube			
	· Line Shaft to Line shaft			
	· Line shaft to top shaft			
3.6	Bearings in Gear Head			
	Thrust bearings Housing			
	a) Type			
	b) Make			
	Bearing Number			
	· Radial Bearing			
	· Radial Bearing			
	· Thrust Bearing			
	c) Type of lubrication			
	d) Lubricator			
3.7	Coupling between Agitator & Gear Head			
	a) Type			
	b) Make & Model No.			
	c) Rating	KW/rpm		
3.8	Stuffing Box/Mechanical Seal			
	a) Type			
	b) Details of gland packing			
	c) No of packing			
	d) Cooling water			
	e) Lubrication type			
	f) Qty of grease and interval of lubrication.			
4	Material of Construction			
a.	Blade of Impeller			
b.	Hub of Impeller			
c.	Base Plate/Gear head Stand			
d.	Line Shaft & Line shaft Coupling			

BIDDER SIGN WITH SEAL AND DATE:

		TECHNICAL SPECIFICATION OF AGITATORS		REF: FGD:AGITATORS
				REV. No. 01
e.	Impeller Shaft			
f.	Top Shaft			
g.	Gland Sleeve			
h.	Location of Thrust bearing			
i.	Coupling guard			
j.	Fasteners in Wet region			
k.	Fasteners in Dry region			
l.	Stuffing Box			
m.	Gland			
n.	Gland packing			
5	Weight			
	a) Bare Agitator weight Kgs			
	b) Rotating Assembly weight Kgs			
	c) Motor weight Kgs			
	d) Gear Head weight Kgs			
	e) Wt. of the equipment, (a+c+d)			
	f) Heaviest single piece component of Agitator to be handled. Kgs			

	TECHNICAL SPECIFICATION OF AGITATORS
FGD:AGITATORS:REV01	

Annexure-III MOTOR SIZING CALCULATION (TO BE FILLED FOR EACH AGITATOR)**Project :****Enquiry No :**

S.No	Parameters		Data
1	Tank size (Dimension in m)		
2	Specific Gravity of Slurry	ρ	
3	IMPELLER TIP DIA(in m)	d	
4	AGITATOR SPEED(RPM)	n	
5	POWER NO OF THE AGITATOR	N_p	
6	NO OF IMPELLER STAGES	I	
7	AGITATOR POWER(P)	$N_p \cdot \rho \cdot d^5 \cdot n^3 \cdot I$	
8	GEARBOX EFFICIENCY	η_1	
9	BEARING TRANSMISSION EFFICIENCY	η_2	
10	EFFICIENCY DUE TO ANY OTHER LOSSES	η_3	
11	MECHAINCAL POWER REQUIRED	$\text{Agitator BKW} = P / (\eta_1 \cdot \eta_2 \cdot \eta_3)$	
12	MOTOR EFFICIENCY	η	
13	Rated Input Power at Motor Terminal at Normal water level and at Normal voltage and Frequency or Agitator BKW	$\text{Power consumed at Motor terminal} = \text{Agitator BKW} / \eta$	
14	MOTOR POWER (KW)	Motor Power shall be at least 1.2 times the Power consumed at Motor Terminal.	

BIDDER SIGN : _____

DESIGNATION : _____

DATE : _____

 BHEL Maharatna Company	TECHNICAL SPECIFICATION OF AGITATORS	REF: FGD:AGITATORS
		REV. No. 01

Annexure-IV MOTOR DATASHEET FOR AGITATORS (TO BE FILLED FOR EACH AGITATOR)

Project :

Enquiry No :

SLNO	Description	DATA
A.	GENERAL	
1.	Manufacturer & Country of origin.	
2.	Equipment driven by motor	"Name of the Agitator"
3.	Motor type	
4.	Quantity	
B.	DESIGN AND PERFORMANCE DATA	
1.	Frame size	
2.	Type of duty	
3.	Type of enclosure /Method of cooling/ Degree of protection	
4.	Applicable standard to which motor generally conforms	
5.	Efficiency class as per IS 12615(IE3)	
6.	(a)Whether motor is flame proof	
	(b)If yes, the gas group to which it conforms as per IS:2148	
7.	Type of mounting	
8.	Direction of rotation as viewed from DE END	
9.	Standard continuous rating at 40 deg.C. Ambient temp. as per Indian Standard (KW)	
10.	Derated rating for specified normal condition i.e. 50 deg. C ambient temperature (KW)	
11.	Maximum continuous load demand of driven equipment in KW	
12.	Rated Voltage (volts)	
13.	Permissible variation of :	
	a. Voltage (Volts)	
	b. Frequency (Hz)	
	c. Combined voltage and frequency	
14.	Rated speed at rated voltage and frequency(RPM)	
15.	At rated Voltage and frequency:	
	a. Full load current	
	b. No load current	

BIDDER SIGN WITH SEAL AND DATE:

 BHEL Bharat Heavy Electricals Limited	TECHNICAL SPECIFICATION OF AGITATORS		REF: FGD:AGITATORS REV. No. 01
16.	Power Factor at		
	a. 100%/75%/50% load		
	b. NO load		
	c. Starting.		
17.	Efficiency at rated voltage and Frequency,		
	a.100% load		
	b. 75% load		
	c. 50% load		
18.	Starting current (amps) at		
	a. 100 % voltage		
	b. 85% voltage		
	c. 80% voltage		
19.	Minimum permissible starting Voltage (Volts)		
20.	Starting time with minimum permissible voltage/80%/ 100%/ 110%		
	a. Without driven equipment coupled		
	b. With driven equipment coupled		
21.	Safe stall time with 100% ,110% & 80% of rated voltage		
	a. From hot condition		
	b. From cold condition		
22.	Torques :		
	a. Starting torque at min. permissible voltage(kg-mtr.)/ rated voltage		
	b. Pull up torque at rated voltage.		
	c. Pull out torque		
	d. Min accelerating torque (kg.m) available at lowest permissible starting voltage		
	e.Rated torque (kg.m)		
23.	Stator winding resistance per phase (ohms at 20 Deg.C.)		
24.	GD2 value of motors		
25.	No of permissible successive starts when motor is in hot condition		
26.	Locked Rotor KVA Input		
27.	Locked Rotor KVA/KW		
28.	Vibration limit :Velocity (mm/s)		
29.	Noise level limit (dBA)		
C.	CONSTRUCTIONAL FEATURES		
1.	Stator winding insulation		

 BHEL Bharat Heavy Electricals Limited	TECHNICAL SPECIFICATION OF AGITATORS	REF: FGD:AGITATORS
		REV. No. 01

	a. Class & Type	
	b. Winding Insulation Process	
	c. Tropicalised (Yes/No)	
	d. Temperature rise over specified maximum ambient temperature of 50 deg C	
	e. Method of temperature measurement	
	f. Stator winding connection	
2.	Main Terminal Box	
	a. Type	
	b. Location(viewed from NDE side)	
	c. Entry of cables(bottom/side)	
	d. Recommended cable size(To be matched with cable size envisaged by owner)	
	e. Fault level (MVA),Fault level duration(sec)	
	f. Cable glands & lugs details (shall be suitable for power cable)	
3.	Type of DE/NDE Bearing	
4.	Motor Paint shade	
5.	Weight of	
	a. Motor stator (KG)	
	b. Motor Rotor (KG)	
	c. Total weight (KG)	
D.	List of accessories.	
1.	Space Heaters (Nos./Power in watts/supply voltage)	
2.	Terminal Box for Space Heater (Yes/No)	
3.	Speed switch (Yes/No) No of contacts and contact ratings of speed switch	
4.	Insulation of bearing (Yes/No)	
5.	Noise reducer(Yes/No)	
6.	Grounding pads	
	i) No and size on motor body	
	ii) Nos on terminal Box	
7.	Any other fitments	
E.	List of curves.	

 Maharatna Company	TECHNICAL SPECIFICATION OF AGITATORS	REF: FGD:AGITATORS
		REV. No. 01
	Torque speed characteristic of the motor	
	Thermal withstand characteristic	
	Starting. current Vs. Time	
	Starting. current Vs speed	
	P.F. and Effi. Vs Load	

BIDDER SIGN WITH SEAL AND DATE:

	TECHNICAL SPECIFICATION OF AGITATORS
FGD:AGITATORS:REV01	

Annexure-V -Schedule of Guarantees (TO BE FILLED FOR EACH AGITATOR)

Project:

Enquiry No:

Agitator Name:

Sl. No.	Description	Unit	Data
1	Rated Input Power at Motor Terminal at Normal water level and at Normal voltage and Frequency (*)	KW	
2	Possible Rate of deposit of solid particles at tank bottom of total solid particle inflow/outflow	%	
2	Noise level at a distance of 1.0 meter from the equipment at site	dB(A)	85
3	Maximum vibration velocity at site (RMS) – Shall meet as the ISO 10816 standard	mm/sec	
4	Life of Agitator components parts from the date of Commissioning for continuous operation		24 months
5	Anti-friction Bearing		25000 hrs.

BIDDER SIGN : _____

DESIGNATION : _____

DATE : _____

	TECHNICAL SPECIFICATION OF AGITATORS	REF: FGD:AGITATORS
		REV. No. 01

Annexure-VI-- LIST OF DEVIATIONS OR EXCEPTIONS TO THE ENQUIRY DOCUMENT

Project :

Enquiry No:

*We hereby accept to the Technical Specification for agitators and **all the parameters for this project**

SIGNATURE OF BIDDER -----

NAME -----

DESIGNATION -----

(OR)

*The following are the technical deviations to the specification:

SI No	Clause No	Page No	Description of Deviation

SIGNATURE OF BIDDER -----

NAME -----

DESIGNATION -----

*Strike out whichever is not applicable

BIDDER SIGN WITH SEAL AND DATE:

Receipt No : 752331/2022/BAP-9762_FGD

Technical Information of Agitators for Mahagenco Bhusawal (1 X 660 MW) FGD system						
REF: BHUSAWAL:FGD:AGITATORS						
PROJECT INFORMATION:						
a.	Owner	Mahagenco Bhusawal				
b.	Capacity (MW)	1X660 MW				
c.	Buyer	BHEL				
c.	Process/Application	Flue Gas Desulphurization				
PROJECT LOCATION						
a.	Country	India				
b.	State/Division	Maharashtra				
c.	District	Jalgaon				
Sl.No.	Description	Absorber Agitator				
1	Parameters					
a.	Type	Horizontal Type (Side Entry)				
b.	Medium to be handled	Gypsum and Limestone slurry				
c.	Seal Type	Mechanical Seal with Flushing				
d.	Emergency Flushing	Applicable				
e.	Duty	Continuous				
f.	Agitator location	Outdoor				
g.	Operation	Whenever Recirculation Pumps are not running and during FGD maintenance or shutdown condition.				
2	Tank Details					
a.	Tank shape	Rectangular				
b.	Tank Name	ABSORBER				
c.	Capacity of slurry (in m3)	1301 m ³				
d.	Dimension (m)	21.9 W x9.9 L x6H (H=liquid height)				
e.	MOC of Agitator					
i.	Impeller blade	Duplex 2507 or better material				
ii.	Impeller Hub	Duplex 2507 or better material				
iii.	Shaft	Duplex 2507 or better material				
iv.	Fasteners in wetted parts or In Tank fasteners	Duplex 2507 or better material				
v.	Fasteners in Non Wetted	GI fastener (40 µ plated) / SS				
vi.	Mounting base	Alloy 926/C276 (Wetted parts)				
vii.	Tank Nozzle (for inserting agitator) with Flange	Carbon Steel with 2mm C276 lining inside the pipe and on the flange face				
viii.	Flush pipe for Start up with flange	FRP or Duplex 2507 or Alloy 59 (Material has to be selected based of flushing velocity)				
ix.	Agitator Support Leg	Carbon Steel				
x.	Slurry contact parts of the Mechanical Seal	Duplex 2507 or better material				
f.	Minimum liquid level in the tank(m)	4.2				
g.	Normal liquid level in the tank	6.0				
h.	Maximum liquid level in the tank(m)	7				
i.	Quantity of Agitators per Tank	2 No's + 1 warehouse spare				
j.	Total Quantity	3 No's				
3	Slurry Analysis					
a.	Slurry to be handled	Gypsum and limestone slurry				
b.	Maximum solid particle size	200 mesh (75 µ)				
c.	Normal solid particle size, d50	325 mesh (43 µ)				
d.	Solid to be handled	Gypsum along with Limestone & other impurities				
e.	Chloride concentration	Max 20000 ppm				
f.	Hardness of particle	5-7 mohs scale				
g.	Slurry concentration, wt%	30%				
h.	Sp. Gravity of slurry	1.204				
i.	Sp. Gravity of Lime Stone & Gypsum	2.32(avg)				
j.	Viscosity of Slurry	10 cP				
k.	pH	4 to 8				
l.	SiO ₂ Content	4 to 6 g/l				
m.	Temperature	Normal -54.2 deg C; Design-70 deg C.				
4	Power loading for auxiliary power consumption	Not applicable				
5	BKW/m3 (minimum)	0.065 KW/m3; Total Slurry volume=1518 m3. Considering each agitator will be handling 759 m3 of slurry, the Min BKW value of each Agitator shall be 49.34 KW (min). Motor shall be designed with 20% margin over the BKW. Above is the Minimum design requirement. However, vendor may decide a higher rating based on their own experience.				
01	18-01-2022	Revised	(sd) MKT	(sd) PNR	(sd) ACR	
00	17-09-2020	Fresh Release	(sd) MKT	(sd) PNR	(sd) RSB	
REV	Date	Description	Prepared	Checked	Approved	

	TECHNICAL SPECIFICATION OF AGITATORS – NTPC PROJECTS FGD:BHUSAWAL:AGITATORS:3K
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ANNEXURE- 3K : Qualifying Requirements for Agitators

The following terminology shall be followed for 3K Document:

- a) Bidder means BHEL
- b) Bidder's sub-vendor means Agitator Manufacturer.
- c) Employer or owner means MAHAGENCO

Agitator Vendor shall meet the below qualification requirement : .

CLAUSE NO	DESCRIPTION			
21.1.1 (a)	The Bidder / Bidder's sub-vendor(s) is required to meet the provenness criteria and/or qualification requirement for critical equipments, auxiliaries, systems and bought out items as per criteria stipulated below			
(b)	Agitators for the Wet Limestone based Flue Gas Desulphurisation (FGD) System offered by the Bidder shall be only from such manufacturer(s) who has previously designed (either by itself or under collaboration / licensing agreement), manufactured / got manufactured the respective equipment(s) of the type, application and minimum equipment rating as stipulated below such that the respective equipment(s) should have been in successful operation in at least one (1) plant for a period not less than one(1) year reckoned as on 30 th June 2019			
	Type and Rating for Qualification			
	Name of Equipment	Type of Equipment	Application	Equipment Rating
	Agitators	Horizontal	Wet Limestone based FGD application in Coal fired power plant (or) Similar process/duty application in petrochemical or metals and mining industry	Agitator rating not less than that supplied for 500 MW or higher size unit for similar application (or) Agitator supplied to tanks and handling 650 m3 slurry for each agitator with slurry concentration ≥ 30% and density ≥ 1220 kg/ m3
4.01.03	A JV / Subsidiary Company formed for manufacturing and supply of equipment(s) as listed at clause no. 4.01.01 above in India, shall also be considered qualified for manufacturing such equipment(s), provided that it has a valid collaboration or licensing agreement for design, engineering, manufacturing of such equipment(s) in India with a qualified equipment manufacturer who meets the requirements stipulated at clause 4.01.01 above (or the technology provider of the qualified equipment manufacturer) for the respective equipment(s). Before taking up the			



TECHNICAL SPECIFICATION OF AGITATORS – NTPC PROJECTS

FGD:BHUSAWAL:AGITATORS:3K

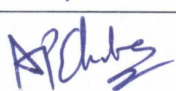
	manufacturing of such equipment(s), the bidder/ his sub-vendor(s) must create /have created manufacturing facilities at his works as per collaborator's/licenser's design, manufacturing and quality control system for such equipment(s). Further, in such a case, such qualified equipment manufacturers should have, directly or indirectly through its holding company/ subsidiary company, at least 26% equity participation in the Indian Joint Venture Company/ Subsidiary Company, which shall be maintained for a lock-in period of seven (7) years from the date of incorporation of such Joint Venture/ Subsidiary or upto the end of defect liability period of the contract, whichever is later
4.01.06	In case the Bidder or the proposed sub-vendor is not manufacturer of proven Agitators as per clause 4.01.01(f) above but is a manufacturer of Agitators for similar process/ duty application in petrochemical or metals and mining industry, the Bidder or the proposed sub-vendor shall also be considered qualified for manufacturing Agitators, provided it has collaboration or valid licensing agreement for design, engineering, manufacturing, supply of such Agitators in India with such manufacturer who meets the requirements stipulated at clause 4.01.01(f) above for the Agitators. Before taking up the manufacturing of such equipment, the bidder/ his sub-vendor must create /have created manufacturing facilities at his works as per collaborator's /licenser's design, manufacturing and quality control system for such equipments
04.01.07	In case the Bidder or the proposed sub-vendor is a manufacturer of Pumps, the Bidder or the proposed sub-vendor shall also be considered qualified for manufacturing Slurry Recirculation Pumps and Slurry Pumps, provided it has collaboration or valid licensing agreement for design, engineering, manufacturing, supply of such equipment in India with such manufacturer who meets the requirements stipulated at clause 4.01.01(b) above for the Slurry Recirculation Pumps and at clause 4.01.01(e) above for the Slurry Pumps. Before taking up the manufacturing of such equipment, the bidder/ his sub-vendor must create /have created manufacturing facilities at his works as per collaborator's /licenser's design, manufacturing and quality control system for such equipment.
04.01.08	Before taking up the manufacturing of such equipment(s) as per clause 4.01.02, 4.01.03, 4.01.04, 4.01.05(i), 4.01.06 & 4.01.07 above, the Bidder / its sub vendor(s) must create (or should have created) manufacturing and testing facilities at its works as per Collaborator / licensor's design, manufacturing and quality control system for such equipments duly certified by the Collaborator / licensor. Further, the Collaborator / Licensor shall provide (or should have provided) all design, design calculation, manufacturing drawings and must provide (or should have provided) technical and quality surveillance assistance and supervision during manufacturing, erection, testing, commissioning of equipments.
04.01.09	Bidder shall offer and supply only the type of the above equipment(s) for which it, itself or the manufacturer / Collaborator(s) / Licensor(s) proposed by the Bidder for the above equipment(s) is qualified.
04.01.10	The Employer reserves the right to fully satisfy himself regarding capability and capacity of Bidder / its sub-vendor(s) and the proposed arrangement and may

	TECHNICAL SPECIFICATION OF AGITATORS – NTPC PROJECTS
FGD:BHUSAWAL:AGITATORS:3K	

	prescribe additional requirement before allowing manufacture of the equipment listed above for this contract.
	Note to clause 4.01.01 : Whenever the term 'coal fired' is appearing above, "Coal" shall be deemed to also include bituminous coal/ brown coal/ Anthracite Coal/lignite.

PRODUCT STANDARD
ELECTRICAL, CONTROLS & INSTRUMENTATION
BAP / BHEL / RANIPET – 632 406

TECI: LT MOTOR: REV 05
PAGE 1 OF 10
EFFECTIVE DATE : 28.07.2021

DOCUMENT TITLE : TECHNICAL SPECIFICATION FOR BOUGHT OUT ITEMS				
ITEM : LT MOTOR				
PROJECT : BHEL STANDARD				
	NAME	DESIGNATION	SIGNATURE	DATE
PREPARED BY	ALAN S G	ENGINEER		28/7/2021
REVIEWED BY	CHANDRASEKAR A P	DM		28-07-2021
APPROVED BY	JEYAMURUGANAND M	AGM		28/07/2021
ISSUED BY EDC – ECI				
RECORD OF REVISIONS:				
REVISION NUMBER 00		INITIAL RELEASE - Dt. 19.03.2013		
REVISION NUMBER 01				
REVISION NUMBER 02		Cl. No: 5- Packing and Drawing included		
REVISION NUMBER 03		Cl. No: 2.20, 2.21, 2.38, 2.39, 2.43 added		
REVISION NUMBER 04		Cl.No: 2.3, 4(b) - ECI:DATASHEET:LT MOTOR:00 added		
REVISION NUMBER 05		Cl.No: 2.36, 2.40, 4(b), 5(a) Updated		

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TECI: LT MOTOR: REV 05
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	<u>SPECIFICATION</u>	<u>VENDOR COMPLIANCE/REMARKS</u>
1	<u>SITE CONDITIONS</u>	
1.1	Altitude above mean sea level	>1000 m.
1.2	Ambient temperature condition	6 to 50°C.
1.3	Relative humidity	100%
1.4	Atmosphere	Tropical, Dusty, salty, corrosive & highly polluted as in a coal based Thermal power plant.
2	<u>GENERAL</u>	
2.1	Reference standards	IS 15999, IS 12615, IS/IEC-60034, IS 1231, IS 6362, IS 2253, IS 12065, IS 12075
2.2	Design ambient	50 Deg.C
2.3	Application/ Type(Normal/ Energy efficient)	As per the document LT MOTOR:PROJECT SPECIFIC DETAILS
2.4	Duty cycle	Continuous S1
2.5	Rated voltage, frequency & Phases	415 V AC $\pm 10\%$; 50 Hz (+5% to -5%); 3 phase
2.6	Combined variation of Voltage and frequency	10% absolute sum
2.7	Motors efficiency class	As per the document LT MOTOR:PROJECT SPECIFIC DETAILS
2.8	Minimum starting voltage	80% of the rated voltage
2.9	Minimum voltage under which motor will run satisfactorily	75% of the rated voltage for 5 minutes
2.10	Capacity to restart (at specified voltage)	i. Two successive starts from cold condition ii. Two HOT restarts starts from Hot condition iii. Three equally spread start per hour
2.11	High speed bus transfer withstand capability	Suitable to withstand 150 % of rated voltage
2.12	Type of balancing for rotor	Dynamic balancing
2.13	Direction of rotation	Suitable for both direction
2.14	Direction of cooling air	Non-drive end to driving end
2.15	Class of insulation	Class F with temperature rise limited to Class B.
2.16	Winding treatment	The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid & tropical climate.
2.17	Allowed winding temperature rise at continuous full load	60°C by thermometer method & 70°C by resistance method
2.18	Accelerating Torque at minimum permissible Starting voltage	10% of full Load Torque

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TECI: LT MOTOR: REV 05
PAGE 3 OF 10
EFFECTIVE DATE : 28.07.2021

2.19	Pullout Torque at rated voltage	205% of full load torque	
2.20.	Ratio of Locked rotor KVA to KW for	As per the document LT MOTOR:PROJECT SPECIFIC DETAILS	
2.21	Starting current	As per the document LT MOTOR:PROJECT SPECIFIC DETAILS	
2.22	Starting time & locked rotor withstand time	The locked rotor withstand time (LRWT) at 110% rated voltage (RV) under HOT condition shall be at least 2.5 sec more than the starting time at 80% of rated voltage for motors with acceleration time upto 20 sec at RV and 5 sec where the accelerating time is more than 20 sec at RV.	
2.23	Momentary overload withstand capability	60% of full load torque for 15 second without any damage.	
2.24	Over speed withstand	120% of rated speed for 2 minutes without any mechanical damage.	
2.25	Hot thermal withstand curve	margin of at least 10% over the full load current	
2.26	Cooling	Totally enclosed fan cooled- IC 411(TEFC)	
2.27	Vibration	The peak amplitude of vibration shall be as per IS 12075	
2.28	Noise level	Within the limits specified by IS 12065 / <85 dB at 1 meter distance from motor.	
2.29	Type of enclosure	TEFC, IP 55 as per IS/IEC 60034-5	
2.30.	Type of mounting	Horizontal foot mounted.	
2.31	Bearings	Ball or roller type / bearings effectively sealed against ingress of dust. The bearing shall be so constructed that the loss of lubricating grease is kept to minimum. Sealed bearings are also acceptable	
2.32	Lubricant Type	Grease	
2.33	Bearing life	minimum life of 40000 Working hours	
2.34	Shaft extension	Key slotted bare shaft extension with key at the driving end.	
2.35	Terminal box Type	Weather proof IP 55 as per IS/IEC 60034-5; Capable of being turned through 360° in steps of 90°.	
2.36	Cable gland and lugs	Double compression type nickel plated brass cable glands and annealed tinned copper crimping lugs to suit the cable size i) Size of power cables will be intimated after PO. ii) For space heater cable glands and lugs suitable for 2CX2.5 to be provided	

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TECI: LT MOTOR: REV 05
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EFFECTIVE DATE : 28.07.2021

2.37	Type of terminals	Stud / screw type with plain washers, spring washers / checknuts & lugs	
2.38	Min.Spacing between Gland plate and Center stud(in mm)	As per the document LT MOTOR:PROJECT SPECIFIC DETAILS	
2.39	Phase to Phase/Phase to Earth air clearance(in mm) in Terminal Box	As per the document LT MOTOR:PROJECT SPECIFIC DETAILS	
2.40.	Fault level	40KA for 0.25Sec	
2.41	Painting	As per the document LT MOTOR:PROJECT SPECIFIC DETAILS	
2.42	Space heaters:		
2.42.a	i) Motors above 30 kW	Separate space heater suitable for 240V, Single Phase, AC,50 Hz	
2.42.b	ii) Motors below 30 kW	Winding shall be suitable for heating at 24 V, Single phase, AC,50 Hz	
2.43	Terminals for space heater	As per the document LT MOTOR:PROJECT SPECIFIC DETAILS	
2.44	RTD for winding	Two numbers of Thermistors / RTD for each phase as below are to be provided A. Motors above 37 Kw shall have thermistors Or RTD if specifically called for in enquiry. B. Motor rated 160kW and above shall have RTDs	
2.45	Bearing RTD	For motors 132 Kw and above	
2.46	Terminals for RTD/ Thermistor	Thermistors/ RTDs shall be terminated in an auxiliary terminal box. Details shall be furnished in TB diagram.	
2.47	Earthing	Two no of earthing provisions on terminal box and on motor body(on opposite sides)	
2.48	Name plate	As per IS/IEC 60034-8 and Additional data on name plate : a. Bearing DE/ NDE details. b. Year of manufacture	
2.49	Lifting Device	Eye bolt or lugs to facilitate safe lifting	
3	INSPECTION & TESTING	As per applicable quality plan	

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4 DOCUMENTS

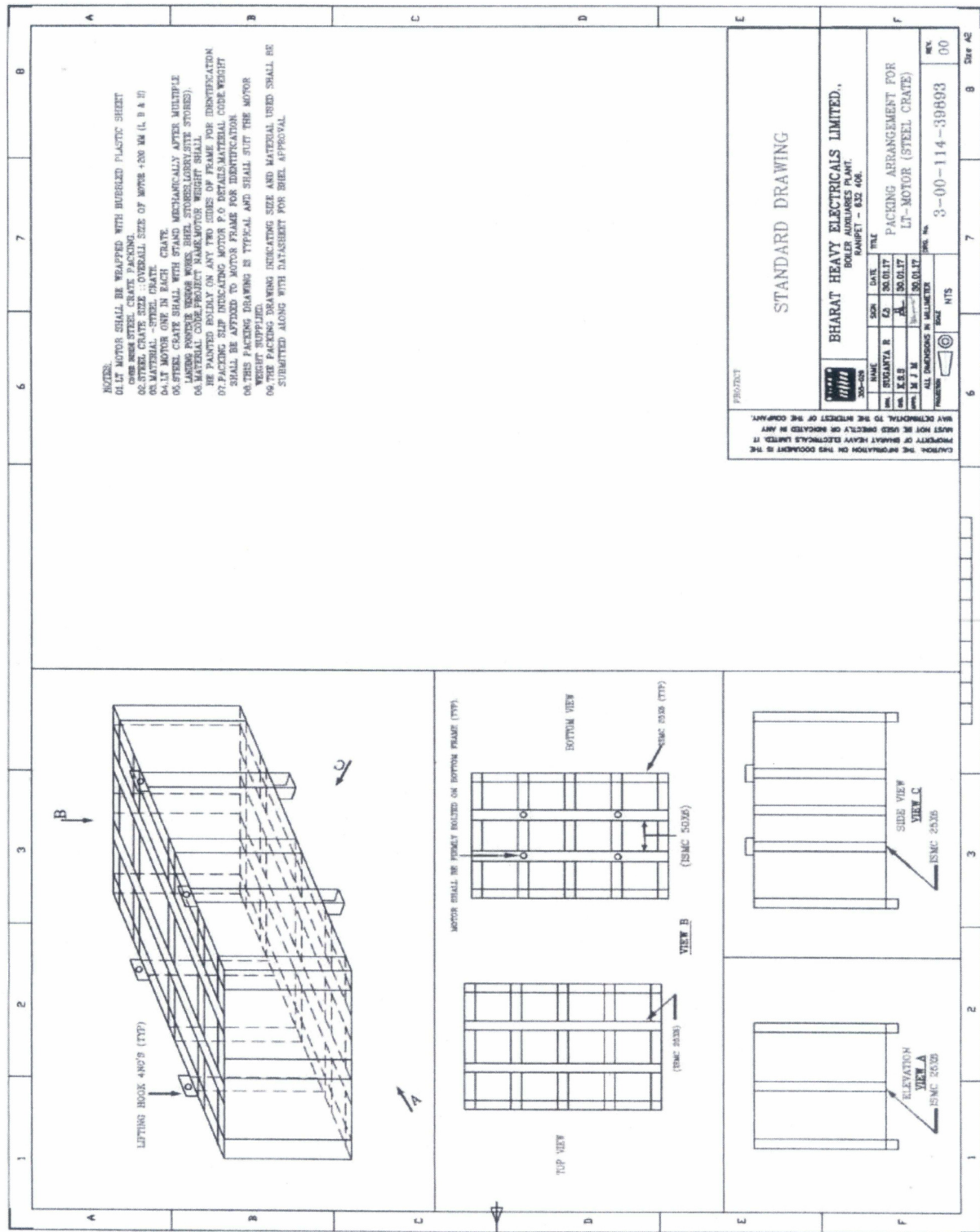
a) Along with offer:	One set of technical data sheet as per the enclosed format and Motor general arrangement drawing giving foundation details, shaft details.	
b) After placement of Purchase order (within 15 days)	Three sets of the following for approval: 1. Technical Data sheet as per the enclosed format ECI:DATASHEET:LTMOTOR:00 2. Motor general arrangement drawing giving foundation details, shaft details and weight 3. Motor Terminal box arrangement drawing 4. Motor characteristic curves : - Torque vs Speed with load curve superimposed - Speed vs Current - Time vs Current - Thermal with stand curve - Load vs Efficiency - Load vs Slip - Load vs Power factor - Speed vs Time - Load vs Current 5. Suggested steel crate packing drawing (Drawing No:- 3-00-114-39893) or vendor standard packing drawing subject to approval. The following shall be submitted: 1. Guarantee certificate. 2. O & M manuals. 3. Acceleration time and LRWT calculation shall be submitted for review.	

5 PACKING

	a) As per suggested Drawing No:- 3-00-114-39893 b) The packing shall meet the Transport, Environment & Storage hazards. c) As per Packing Procedure QA:CI: STD:PR:03 or as per Manufacturer's Standard Practice subject to approval.	
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ECI: DATASHEET: LTMOTOR: 00

TECHNICAL DATA SHEET OF LT MOTOR

P.O No:

DATA SHEET - Customer No: Project:

CL.NO	CHARACTERISTICS	VENDOR DATA(To be filled by Vendor)
1.0	Application	
1.1	Fan / Load Curve referred	
2.0	Manufacturer	
3.0	Type & frame size	Normal/ Energy efficient Frame size:
3.1	Degree of Protection	IP55
4.0	Rated output in kW	
4.1	Rated speed	
5.0	Rated voltage , frequency & phases	415 V $\pm$ 10% AC; 50 Hz $\pm$ 5%; (Check voltage as per Enquiry) 10% absolute sum; 3 phase
6.0	Full load current	Amps
7.0	Energy efficient	As per IS 12615
8.0	Efficiency & power factor at Full load	Eff- Pf-
9.0	Efficiency & power factor at 75 % load	Eff- Pf-
10.0	Efficiency & power factor at 50 % load	Eff- Pf-
11.0	Duty Cycle	Sl - Continuous
12.0	Rated torque	
13.0	Starting current	As per IS standards
14.0	No load current (with mechanism coupled)	(at Rated.V and Frequency)
15.0	Starting torque in % of full load torque	
16.0	Pull up torque in % of full load torque	
17.0	Pull out torque in % of full load torque	

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18.0	No load starting time (without mechanism coupled)	
19.0	Locked rotor withstand time at rated voltage	a.Hot b.Cold
20.0	Locked rotor withstand time at minimum starting voltage	a.Hot b.Cold
21.0	Locked rotor withstand time at 110% rated voltage	a.Hot b.Cold
22.0	Starting time at minimum starting voltage with mechanism coupled	
23.0	Starting time at rated voltage with mechanism coupled	
24.0	Maximum permissible starting time	
25.0	Stator thermal time constant	Minutes
26.0	Type & No of terminals brought out	
27.0	Stator winding connection	Delta / Star
28.0	Class of insulation & temperature rise	Class F; 60 ⁰ C by thermometer method / 70 ⁰ C by resistance method.
29.0	Minimum permissible starting voltage	Volts
30.0	Resistance per phase at 20Deg C (Indicative)	Ohms
31.0	No of successive starts in Hot condition	
32.0	Quantity and power consumption of space heater	Quantity: Watts:
33.0	Direction of rotation	Bi-Directional.
34.0	Bearing make & type	Make: Drive End: Non Drive End:
35.0	Lubricant quantity grade & recommended interval of lubrication	

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36.0	Type of mounting & shaft orientation	Foot mounting; Horizontal.
	<u>Terminal Box</u>	
37.0	Location & angle of rotation	
38.0	Gland size for stator winding	
39.0	Gland size for space heater	Suitable for 2CX2.5 sq.mm (armoured), if applicable.
40.0	Cable entry	
41.0	GD ² of motor (kg-m ²)	
42.0	Total weight of motor (kg).	
43.0	Weight of stator (kg)	
44.0	Weight of rotor (kg)	
45.0	Anticipated bearing life in Hours	
46.0	Method of connection to driven equipment	
47.0	Limiting rotor temperature for determining safe stall time	
48.0	RTD for winding/ Bearing	Applicable: YES ☐ NO ☐
49.0	Grade of balance of motor	
50.0	Standard continuous rating at 40 Deg C ambient.	
51.0	Derated rating of motor at 50 Deg C.	
52.0	a. Locked Rotor KVA	
	b. Ratio of Locked rotor KVA / Rated KW	
53.0	a. Motor Dynamic Load	Upward/ Downward—
	b. Motor Static load	Upward / Downward—
54.0	PAINT SHADE	

Vendor's signature and seal

Rev No :

Date :

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The following curves are to be enclosed during datasheet approval.

1. GA drawing , Terminal box arrangement
2. Torque Vs Speed with load curve superimposed.
3. Speed Vs Current
4. Time Vs Current
5. Thermal with stand curve
6. Load Vs Efficiency
7. Load Vs Slip
8. Load Vs Power factor
9. Speed Vs Time
10. Load Vs Current.

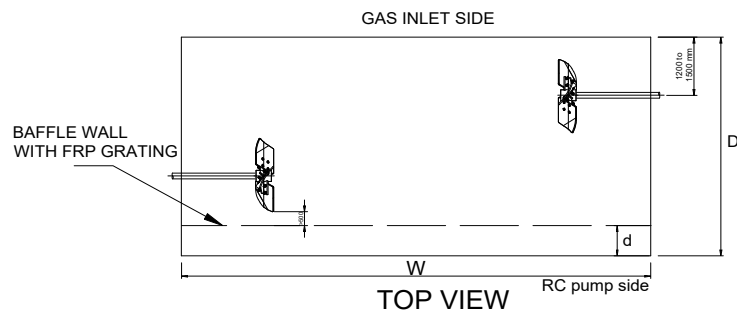
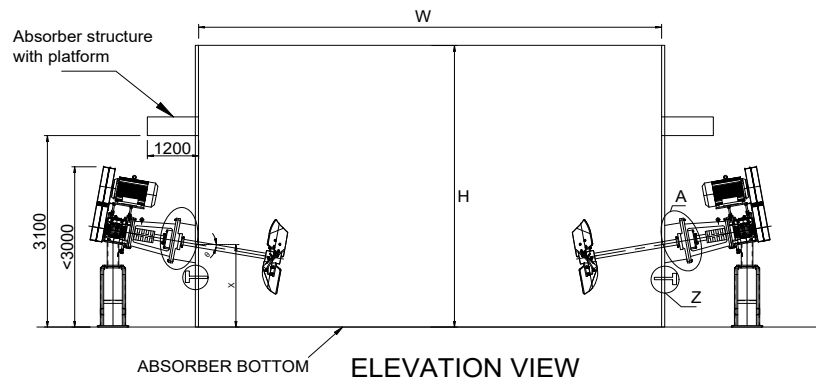
The following information shall be specifically provided for motors suitable for VFD drive (if called for in eqny during datasheet approval in addition to datasheet.

1. Stator Resistance
2. Stator leakage reactance
3. Magnetising reactance
4. Rotor resistance referred to stator
5. Rotor reactance referred to stator

Vendor's signature and seal.

Date

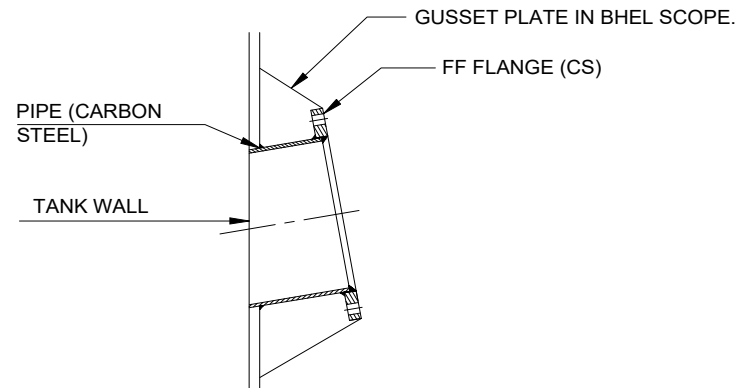
BHEL DRG NO.: 3-FW-720-06915



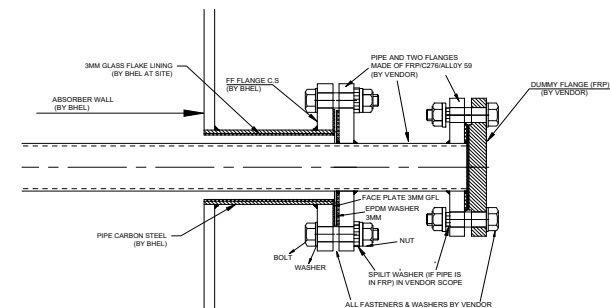
NOTE-

- 1- ALL DIMENSIONS ARE IN MM.
- 2- TYPICAL ARRANGEMENT IS SHOWN WITH V BELT & PULLEY. VENDOR CAN ALSO OFFER GEAR BOX DRIVEN AGITATOR.
- 3- FOR TANK HEIGHT (H), WIDTH(W) AND DEPTH(D), BIDDER SHALL REFER TO BE TECHNICAL INFORMATION OF AGITATORS.
- 4- BAFFLE WALL IS LOCATED AT A DISTANCE 'd' FROM THE ABSORBER WALL
IF $D \leq 9900$ MM, THEN $d = 2200$ MM
IF $D > 9900$ MM, THEN $d = (D - 8000)$ MM
THE ABSORBER AGITATOR SHALL BE DESIGNED TO PREVENT THE SLURRY SETTLEMENT AT BOTTOM OF THE ENTIRE TANK INCLUDING THE AREA BETWEEN THE BAFFLE WALL AND THE ABSORBER WALL.
- 5- THE AGITATOR LOCATION SHALL BE SUGGESTED BY VENDOR CONSIDERING THE LOCATION OF THE BAFFLE WALL. BAFFLE WALL IS MADE OF FRP GRATINGS, VENDOR TO INDICATE THE VALUE OF X AND θ IN THEIR OFFER.
- 6- FOUNDATION BOLTS/ ANCHOR BOLTS SHALL BE PROVIDED BY VENDOR. EMBEDMENT PLATES IF REQUIRED, SHALL BE PROVIDED BY VENDOR.

AGITATOR NOZZLE WILL BE PROVIDED BY BHEL. VENDOR HAS TO PROVIDE ALL THE FASTENERS FOR MOUNTING THE AGITATOR. VENDOR HAS TO PROVIDE ALL THE LOAD DETAILS FOR DESIGN OF NOZZLE. TANK ALONG WITH THE NOZZLE WILL BE 3MM GLASS FLAKE LINED.



DETAIL-A
(AGITATOR NOZZLE)



DETAIL-Z
(EMERGENCY FLUSH PIPE ARRANGEMENT)

CAUTION: The information on this drawing is the property of BHARAT HEAVY ELECTRICALS LTD. It must not be used directly or indirectly in any way without the prior written consent of the company.	CUSTOMER/PROJECT:TSGENCO		FGD SYSTEM PACKAGE			
		Bharat Heavy Electricals Ltd		NAME	DATE	NO. OF VAR
		BOILER AUXILIARIES PLANT RANIPET-632 406	DRN	S. SHANMUGA SUNDARAM	08/10/2021	—
			CKD	S. SHANMUGA SUNDARAM	08/10/2021	
			APD	V. KESAVAN	08/10/2021	
	TITLE:		SCALE			
	TYPICAL ARRANGEMENT OF SIDE ENTRY AGITATOR IN ABSORBER TANK		 N.T.S.			
			BHEL DRG NO: 3-FW-720-06915		REV	

Size A3